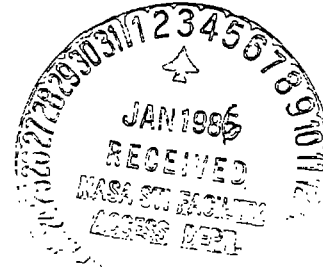


DOE/NASA/0153-4
NASA CR-174737
84AEPD004

N8615728



Mod-5A Wind Turbine Generator Program Design Report

Volume IV—Drawings and Specifications Book 3

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General Electric Company
(Advanced Energy Programs Department)

August 1984

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
Under Contract DEN 3-153

for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Division of Wind Energy Technology

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Washington, D.C. 20545
Under Interagency Agreement DE-AI01-79ET20305

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Springfield, VA 22161

Volume I, Executive Summary

Volume I contains an overview of the MOD-5A Program. These topics are covered:

- Objectives of the MOD-5A Program
- Description of the Final Design (Model 304.2)
- Cost of Energy
- Power Output
- Trade-Off Studies
- Development Tests
- Analyses of Loads and Dynamics
- Manufacturing and Quality Assurance and Safety Plans

Volume II, Conceptual and Preliminary Design

These sections comprise Volume II, which is divided into two books, as follows:

<u>Book 1</u>	1.0	Summary
	2.0	Introduction
	3.0	Design Requirements
	4.0	Conceptual Design Studies
	5.0	Design, Development, and Optimization
	6.0	System Dynamics Analysis
	7.0	System Loads Analysis

<u>Book 2</u>	8.0	Development Tests
	9.0	Design Criteria
		Appendix A System Specification
		Appendix B Design Load Tables

Volume III, Final Design and System Description

These sections comprise Volume III, which is divided into two books, as follows:

<u>Book 1</u>	1.0	Summary
	2.0	Introduction
	3.0	System Description - Model 304.2
	4.0	Rotor Subsystem
	5.0	Drivetrain Subsystem
	6.0	Nacelle Subsystem
	7.0	Tower and Foundation Subsystems

<u>Book 2</u>	8.0	Power Generation Subsystem
	9.0	Control and Instrumentation Subsystems
	10.0	Manufacturing
	11.0	Site and Erection
	12.0	Quality Assurance and Safety
	13.0	FMEA, RAM and Maintenance
Appendix A		C.F. Braun & Company - Foundation Design Criteria
Appendix B		GE - Product Assurance Program Plan for the MOD-5A WTG Program
Appendix C		GE - System Safety Plan for the MOD-5A Program
Appendix D		GE - MOD-5A Configuration Management Plan
Appendix E		GE - MOD-5A Defect Reports for Development Hardware
Appendix F		GE - MOD-5A Program Quality Assurance Requirements for the Control of Raw Materials and the Blade Fabrication Process
Appendix G		GE - Statement of Work for the Erection of the MOD-5A WTG Yaw, Nacelle and Blade Subsystems

Volume IV, Drawings and Specifications

This volume contains the numbered drawings and specifications for the final design of the MOD-5A wind turbine. The volume is divided into five books, as follows:

<u>Book 1</u>	47A380002 through 47A380030
<u>Book 2</u>	47A380031 through 47A380068
<u>Book 3</u>	47A380074 through 47A380126
<u>Book 4</u>	47A380128 through 47A387125
<u>Book 5</u>	47D381002 through 47D387130

Volume IV of the MOD-5A Wind Turbine Generator Program Design Report contains the drawings and specifications for the baseline configuration in ascending drawing number order. Due to binding limitations, this volume is presented in multiple books.

Each book contains a full breakdown parts listing, as well as "where-used" list. The first and last drawing number in each part is noted below to indicate in which part of Volume IV to locate a particular drawing.

<u>Volume IV</u>	<u>First Drawing</u>
Part 1	47A380002 through 47A380030
Part 2	47A380031 through 47A380068
Part 3	47A380074 through 47A380126
Part 4	47A380128 through 47A387125
Part 5	47D381002 through 47D387130

NOTES: Part numbers preceded by "***" or not starting with "47-" are either standard hardware, vendor numbers, or unissued drawings. These numbers appear on the parts lists, but are not included in the volume.

DRAWINGS AND SPECIFICATIONS



WTG - MOD 5A

DRAWING LIST

(NUMERICAL SEQUENCE)

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE P T APPLY C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT							
47A380024	INSTL CABLING REQ			X	0000	EA	47E382304G1		X	001867
47A380030	SPEC SYST DISP PNL			X	0000	EA	47E387112G1		X	001849
47A380046	CONT ELEK CAB SPEC			X	0000	EA	47E387062G1		X	000564
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47D387083G1		X	000663
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47D387089G1		X	001561
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47D387113G1		X	001774
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47D387121G1		X	000877
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47D387130G1		X	000914
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387027G1		X	001370
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387037G1		X	000701
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387062G1		X	000561
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387072G1		X	000777
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387084G1		X	001811
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387085G1		X	001636
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387091G1		X	001513
47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	47E387095G1		X	000638
									00.000	
47A380067	CONT SYST U.P.S. SPEC			M	0000	EA	47E387081G1	01.000	01.000	001318
47A380068	30-KVA XFMR SPEC			M	0000	EA	47E387081G1	01.000	01.000	001316
47A380069P31	NAMEPLATE, IDENT (J1)			*	0000	EA	47E387027G1	01.000	01.000	001345
47A380069P31	NAMEPLATE, IDENT (J1)			*	0000	EA	47E387084G1	01.000	01.000	001822
47A380069P31	NAMEPLATE, IDENT (J1)			*	0000	EA	47E387085G1	01.000	01.000	001646
47A380069P31	NAMEPLATE, IDENT (J1)			*	0000	EA	47E387091G1	01.000	01.000	001524
									04.000	
47A380069P32	NAMEPLATE, IDENT (J2)			*	0000	EA	47E387084G1	01.000	01.000	001823
47A380069P32	NAMEPLATE, IDENT (J2)			*	0000	EA	47E387085G1	01.000	01.000	001647
47A380069P32	NAMEPLATE, IDENT (J2)			*	0000	EA	47E387091G1	01.000	01.000	001525
									03.000	
47A380069P33	NAMEPLATE, IDENT (J3)			B	0000	EA	47E387084G1	01.000	01.000	001824
47A380069P33	NAMEPLATE, IDENT (J3)			B	0000	EA	47E387091G1	01.000	01.000	001526
									02.000	
47A380069P52	NAMEPLATE, IDENT (TB*)			*	0000	EA	47E387072G1	01.000	01.000	000782
47A380069P71	NAMEPLATE, IDENT (GND)			*	0000	EA	47E387027G1	01.000	01.000	001346
47A380070P3	NPL, AN/REV STATUS			*	0000	EA	47E387027G1	01.000	01.000	001348
47A380070P3	NPL, AN/REV STATUS			*	0000	EA	47E387062G1	01.000	01.000	000560
47A380070P3	NPL, AN/REV STATUS			*	0000	EA	47E387072G1	01.000	01.000	000677
47A380070P3	NPL, AN/REV STATUS			*	0000	EA	47E387084G1	01.000	01.000	001825
47A380070P3	NPL, AN/REV STATUS			*	0000	EA	47E387085G1	01.000	01.000	001648

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG	PL-LATE								
		INC	OUT	APPLY	C Y						
47A380070P3	NPL, AN/REV STATUS			*	0000	EA		47E387091G1	01.000	01.000	001527
47A380070P3	NPL, AN/REV STATUS			*	0000	EA		47E387095G1	01.000	01.000	000640
										07.000	
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47D387121G1	AR		000881
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47D387130G1	AR		000920
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387027G1	AR		001366
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387062G1	AR		000954
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387072G1	AR		000784
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387084G1	AR		001818
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387085G1	AR		001642
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387091G1	AR		001520
47A380071PAR	SLEEVING, SHRINK			*	0000	FT		47E387095G1	AR		000643
										00.000	
47A380094	7500KVA VAR SP GEN			X	0000	EA		47E387081G1	X		001864
47A380102	FINISH			X	0000	PT		47C387096G1	X		000827
47A380102	FINISH			X	0000	PT		47E387084G1	X		001847
										00.000	
47A380102P1	FINISH			M	0000	QT		47D387121G1	AR		000878
47A380102P1	FINISH			M	0000	QT		47D387130G1	AR		000917
										00.000	
47D381002P1	BEARING, YAW			M	0000	EA		47E382133G1	01.000	01.000	000025
47D381003P1	ACTUATOR, HYDRAULIC			M	0000	EA		47E382165G1	04.000	04.000	000032
47D381010P1	BRAKE ASSY			M	0000	EA		47E382165G1	08.000	08.000	000031
47D381010P2	BRAKE ASSY			M	0000	EA		47E382603G1	02.000	04.000	000218
47D381010P2	BRAKE ASSY			M	0000	EA		47E382603G2	02.000	04.000	000246
										08.000	
47E381017	YAW SR ELECT INTFC			X	0000	EA		47E382594G1	X		000109
47D381018	ELEC INTERFACE			X	0000	EA		47E382599G1	X		001236
47D381019P1	SLIP RNG UN YAW AXIS			M	0000	EA		47E382594G1	01.000	01.000	000108
47D381020P1	ROTOR SLIPRING UNIT			M	0000	EA		47E382599G1	01.000	01.000	001237
47D381024P1	ROTARY POSITION SR			M	0000	EA		47E382599G1	01.000	01.000	001252
47C381030P1	HINGE, TRAP DOOR			*	0000	EA		47D382430G1	01.000	02.000	000397
47C381030P1	HINGE, TRAP DOOR			*	0000	EA		47D382430G2	01.000	02.000	000405
47C381030P1	HINGE, TRAP DOOR			*	0000	EA		47D382474G1	01.000	01.000	000414
47C381030P1	HINGE, TRAP DOOR			*	0000	EA		47D382474G2	01.000	01.000	000422
										06.000	

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE P T APPLY C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT							
47C381036P1	BOLT,FATIGUE RATED			B	0000	EA	47E382363G1	14.000	14.000	000350
47C381036P10	BOLT,FATIGUE RATED			B	0000	EA	47E382363G1	12.000	12.000	000327
47C381036P10	BOLT,FATIGUE RATED			B	0000	EA	47E382496G1	08.000	08.000	001270
47C381036P10	BOLT,FATIGUE RATED			B	0000	EA	47E382608G1	60.000	60.000	001291
									80.000	
47C381036P14	BOLT,FATIGUE RATED			B	0000	EA	47E382602G1	16.000	16.000	000167
47C381036P14	BOLT,FATIGUE RATED			B	0000	EA	47E382603G1	12.000	24.000	000238
47C381036P14	BOLT,FATIGUE RATED			B	0000	EA	47E382603G2	12.000	24.000	000265
									64.000	
47C381036P15	BOLT,FATIGUE RATED			B	0000	EA	47E382165G1	36.000	36.000	000045
47C381036P16	BOLT,FATIGUE RATED			B	0000	EA	47E382165G1	12.000	12.000	000046
47C381036P2	BOLT,FATIGUE RATED			B	0000	EA	47E382363G1	32.000	32.000	000324
47C381036P2	BOLT,FATIGUE RATED			B	0000	EA	47E382602G1	20.000	20.000	000174
									52.000	
47C381036P20	BOLT,FATIGUE RATED			B	0000	EA	47D382598G1	08.000	08.000	000548
47C381036P20	BOLT,FATIGUE RATED			B	0000	EA	47E382363G1	88.000	88.000	000326
47C381036P20	BOLT,FATIGUE RATED			B	0000	EA	47E382597G1	120.000	120.000	000537
									216.000	
47C381036P21	BOLT			B	0000	EA	47E382608G1	08.000	08.000	001295
47C381036P22	BOLT,FATIGUE RATED			B	0000	EA	47D382598G1	08.000	08.000	000549
47C381036P24	BOLT,FATIGUE RATED			B	0000	EA	47D382598G1	08.000	08.000	000547
47C381036P24	BOLT,FATIGUE RATED			B	0000	EA	47E382441G1	36.000	36.000	000196
									44.000	
47C381036P25	BOLT,FATIGUE RATED			B	0000	EA	47E382363G1	36.000	36.000	000328
47C381036P26	BOLT,FATIGUE RATED			B	0000	EA	47E382363G1	12.000	12.000	000348
47C381036P26	BOLT,FATIGUE RATED			B	0000	EA	47E382607G1	96.000	96.000	001279
									108.000	
47C381036P3	BOLT,FATIGUE RATED			B	0000	EA	47E382496G1	84.000	84.000	001268
47C381036P32	BOLT			M	0000	EA	47E382133G1	144.000	144.000	000026
47C381036P4	BOLT,FATIGUE RATED			M	0000	EA	47E382306G1	20.000	20.000	000310
47C381036P40	BOLT, STRUCT. 2-12			M	0000	EA	47E382306G1	24.000	24.000	000307
47C381036P5	BOLT,FATIGUE RATED			B	0000	EA	47E382495G1	24.000	48.000	001267

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IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE P T APPLY C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT							
47C381036P50	BOLT			B	0000	EA	47E382553G1	36.000	36.000	000366
47C381036P6	BOLT, FATIGUE RATED			B	0000	EA	47E382363G1	60.000	60.000	000325
47C381036P6	BOLT, FATIGUE RATED			B	0000	EA	47E382602G1	20.000	20.000	000170
									80.000	
47A381037P1	LACING TAPE			*	0000	FT	47D387121G1	AR		000880
47A381037P1	LACING TAPE			*	0000	FT	47D387130G1	AR		000919
47A381037P1	LACING TAPE			*	0000	FT	47E387062G1	AR		000853
47A381037P1	LACING TAPE			*	0000	FT	47E387072G1	AR		000773
47A381037P1	LACING TAPE			*	0000	FT	47E387084G1	AR		001820
47A381037P1	LACING TAPE			*	0000	FT	47E387085G1	AR		001644
47A381037P1	LACING TAPE			*	0000	FT	47E387091G1	AR		001522
47A381037P1	LACING TAPE			*	0000	FT	47E387095G1	AR		000642
									00.000	
47A381038P3	TAPE, LACING			*	0000	FT	47E387027G1	AR		001367
47C381039P1	EXPANSION JOINT			M	0000	EA	47E382570G1	02.000	02.000	000519
47C381039P2	EXPANSION JOINT			M	0000	EA	47E382570G1	01.000	01.000	000520
47D381040P1	HEAT EXCHANGER			M	0000	EA	47E387062G1	02.000	02.000	000555
47A381043PAR	SLEEVING, VINYL			*	0000	FT	47E387062G1	AR		000955
47A381043PAR	SLEEVING, VINYL			*	0000	FT	47E387072G1	AR		000774
47A381043PAR	SLEEVING, VINYL			*	0000	FT	47E387095G1	AR		000629
									00.000	
47A381044PAR	SLEEVING, TEFLON			*	0000	FT	47D387089G1	AR		001383
47A381044PAR	SLEEVING, TEFLON			*	0000	FT	47D387121G1	AR		000868
47A381044PAR	SLEEVING, TEFLON			*	0000	FT	47D387130G1	AR		000921
47A381044PAR	SLEEVING, TEFLON			*	0000	FT	47E387084G1	AR		001819
47A381044PAR	SLEEVING, TEFLON			*	0000	FT	47E387085G1	AR		001643
47A381044PAR	SLEEVING, TEFLON			*	0000	FT	47E387091G1	AR		001521
									00.000	
47A381044P5	SLEEVING			B	0000	FT	47D387113G1	AR		001469
47A381045PAR	CLAMP, LOOP-CUSHIONED			M	0000	EA	47E387062G1	AR		000579
47A381045P3	CLAMP, CABLE (.187 DI*)			*	0000	EA	47E387072G1	02.000	02.000	000743
47A381045P5	CABLE CLAMP			B	0000	EA	47E387084G1	03.000	03.000	001817
47A381045P5	CABLE CLAMP			B	0000	EA	47E387085G1	03.000	03.000	001641
47A381045P5	CABLE CLAMP			B	0000	EA	47E387091G1	03.000	03.000	001519
									09.000	
47A381045P6	CLAMP, CABLE (.375 DI*)			*	0000	EA	47E387072G1	04.000	04.000	000744

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE P T APPLY C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT							
47E381046P1	GEARBOX ENVELOPE			B	0000	EA	47E382553G1	01.000	01.000	000364
47B381059P4	CONNECTOR CUTOUT COV*			*	0000	EA	47E387072G1	03.000	03.000	000680
47D381060P1	VIDEO MONITOR			M	0000	EA	47E387112G1	01.000	01.000	001327
47C381066P1	HOSE ASSY			M	0000	EA	47J382330G1	04.000	04.000	001126
47C381066P2	HOSE ASSY			M	0000	EA	47J382330G1	06.000	06.000	001125
47A381067P1	CTL PROCESSING UNIT			M	0000	EA	47E387095G1	01.000	01.000	000594
47A381067P10	120 VAC TRK OUT MDL			M	0000	EA	47E387062G1	47.000	47.000	000570
47A381067P11	12-BIT A/D CONVERTER			M	0000	EA	47E387095G1	02.000	02.000	000603
47A381067P12	12-BIT SS ANLG INPUT			M	0000	EA	47E387095G1	03.000	03.000	000604
47A381067P13	12-BIT ANALOG OUTPUT			M	0000	EA	47E387095G1	02.000	02.000	000605
47A381067P14	WATCHDOG TIMER			M	0000	EA	47E387095G1	01.000	01.000	000601
47A381067P15	ERROR DETECTOR			M	0000	EA	47E387095G1	01.000	01.000	000600
47A381067P16	POWER SUPPLY			M	0000	EA	47E387095G1	01.000	01.000	000591
47A381067P17	CHASSIS INTERFACE			M	0000	EA	47E387095G1	01.000	01.000	000595
47A381067P18	CHASSIS			M	0000	EA	47E387095G1	02.000	02.000	000592
47A381067P2	ARITH. PROCESSING			M	0000	EA	47E387095G1	01.000	01.000	000599
47A381067P20	FILLER BLANK			M	0000	EA	47E387095G1	15.000	15.000	000602
47A381067P23	CABLE, I/O TRACK			M	0000	EA	47E387062G1	01.000	01.000	000575
47A381067P3	16K EXECUTIVE MEMORY			M	0000	EA	47E387095G1	01.000	01.000	000596
47A381067P31	TERMINATOR PLUG			M	0000	EA	47E387062G1	01.000	01.000	000571
47A381067P4	12K PROM, 4K RAM MEM			M	0000	EA	47E387095G1	01.000	01.000	000598
47A381067P5	16K RAM MEMORY			M	0000	EA	47E387095G1	01.000	01.000	000597
47A381067P6	TTY & EIA INTFC MDL			M	0000	EA	47E387095G1	03.000	03.000	000606
47A381067P7	I/O SYS DRIVER MDL			M	0000	EA	47E387095G1	01.000	01.000	000607
47A381067P8	I/O TRACK			M	0000	EA	47E387062G1	08.000	08.000	000568

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OF POOR QUALITY

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---				CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT	P T APPLY	C Y						
47A381067P9	120 VAC TRK INP MDL			M	0000		EA	47E387062G1	81.000	81.000	000569
47C381072P1	CLAMP UNIT			M	0000		EA	47J382330G1	04.000	04.000	001138
47C381072P2	CLAMP UNIT			M	0000		EA	47J382330G1	52.000	52.000	001137
47C381072P3	CLAMP UNIT			M	0000		EA	47C382336G1	01.000	38.000	001133
47C381072P3	CLAMP UNIT			M	0000		EA	47C382336G2	01.000	08.000	001136
47C381072P3	CLAMP UNIT			M	0000		EA	47C382336G3	01.000	06.000	001186
										52.000	
47B381074P1	HOSE ASSY			M	0000		EA	47J382313G1	02.000	02.000	000086
47C381075P1	HOSE ASSY			M	0000		EA	47J382313G1	04.000	04.000	000084
47C381075P2	HOSE ASSY			M	0000		EA	47J382313G1	04.000	04.000	000085
47D381078P1	HIGH SPEED SFT ASSY			B	0000		EA	47D382589G1	01.000	01.000	000372
47D381080P1	TPR RLR BRG,SPDL/AFT			M	0000	80657	EA	47E382441G1	01.000	01.000	000178
47D381081P1	TPR RLR BRG,SPDL/FWD			M	0000	80657	EA	47E382441G1	01.000	01.000	000179
47D381082P1	COUPLING HUB, FWD			*	0000		EA	47D382435G1	01.000	01.000	000210
47D381082P2	TORQUE PLATE			M	0000		EA	47E382441G1	01.000	01.000	000195
47C381083P1	COUPLING HUB, AFT			*	0000		EA	47D382435G1	01.000	01.000	000211
47C381084P1	VALVE, THERMO, AMOT			M	0000		EA	47E382579G1	01.000	01.000	000477
47C381086P1	VALVE, RELIEF, 4-IN			M	0000		EA	47E382579G1	01.000	01.000	000478
47C381087P1	NUT			M	0000		EA	47E382306G1	20.000	20.000	000311
47C381087P1	NUT			M	0000		EA	47E382610G1	28.000	56.000	001028
										76.000	
47C381087P10	LOCKNUT			B	0000		EA	47E382363G1	124.000	124.000	000331
47C381087P10	LOCKNUT			B	0000		EA	47E382608G1	08.000	08.000	001296
										132.000	
47C381087P13	NUT, FATIGUE RATED			B	0000		EA	47E382133G1	144.000	144.000	000027
47C381087P13	NUT, FATIGUE RATED			B	0000		EA	47E382597G1	120.000	120.000	000538
										264.000	
47C381087P18	NUT 2-12			M	0000		EA	47E382306G1	24.000	24.000	000308
47C381087P2	LOCKNUT			B	0000		EA	47E382363G1	92.000	92.000	000329
47C381087P2	LOCKNUT			B	0000		EA	47E382602G1	40.000	40.000	000173
										132.000	

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE APPLY	P T C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT								
47C381087P22	LOCKNUT				B	0000	EA	47E382553G1	36.000	36.000	000368
47C381087P5	NUT				B	0000	EA	47E382441G1	360.000	360.000	000200
47C381087P5	NUT				B	0000	EA	47E382603G1	12.000	24.000	000239
47C381087P5	NUT				B	0000	EA	47E382603G2	12.000	24.000	000266
										408.000	
47C381087P6	LOCKNUT				B	0000	EA	47E382363G1	12.000	12.000	000330
47C381087P6	LOCKNUT				B	0000	EA	47E382608G1	60.000	60.000	001292
										72.000	
47C381087P9	NUT				B	0000	EA	47D382598G1	24.000	24.000	000546
47C381087P9	NUT				B	0000	EA	47E382363G1	12.000	12.000	000349
47C381087P9	NUT				B	0000	EA	47E382441G1	36.000	36.000	000198
47C381087P9	NUT				B	0000	EA	47E382607G1	96.000	96.000	001280
										168.000	
47C381088P1	WASHER, 1.00 DIA				M	0000	EA	47E382306G1	20.000	20.000	000319
47C381088P1	WASHER, 1.00 DIA				M	0000	EA	47E382363G1	92.000	92.000	000332
47C381088P1	WASHER, 1.00 DIA				M	0000	EA	47E382496G1	84.000	84.000	001269
47C381088P1	WASHER, 1.00 DIA				M	0000	EA	47E382602G1	40.000	40.000	000171
47C381088P1	WASHER, 1.00 DIA				M	0000	EA	47E382610G1	28.000	56.000	001029
										292.000	
47C381088P10	WASHER, 1.50 DIA				B	0000	EA	47D382598G1	24.000	24.000	000552
47C381088P10	WASHER, 1.50 DIA				B	0000	EA	47E382363G1	136.000	136.000	000346
47C381088P10	WASHER, 1.50 DIA				B	0000	EA	47E382607G1	96.000	96.000	001282
47C381088P10	WASHER, 1.50 DIA				B	0000	EA	47E382608G1	68.000	68.000	001298
										324.000	
47C381088P13	WASHER, HARDENED STL				B	0000	EA	47E382133G1	144.000	144.000	000028
47C381088P13	WASHER, HARDENED STL				B	0000	EA	47E382597G1	120.000	120.000	000540
										264.000	
47C381088P14	WASHER, HARDENED STL				B	0000	EA	47E382133G1	144.000	144.000	000029
47C381088P14	WASHER, HARDENED STL				B	0000	EA	47E382597G1	120.000	120.000	000539
										264.000	
47C381088P17	WASHER 2.00				M	0000	EA	47E382306G1	24.000	24.000	000318
47C381088P18	WASHER 2.00				B	0000	EA	47E382306G1	24.000	24.000	000309
47C381088P2	WASHER, 1.00 DIA				M	0000	EA	47E382306G1	20.000	20.000	000312
47C381088P2	WASHER, 1.00 DIA				M	0000	EA	47E382363G1	105.000	105.000	000345
47C381088P2	WASHER, 1.00 DIA				M	0000	EA	47E382602G1	40.000	40.000	000172
										165.000	
47C381088P21	WASHER				B	0000	EA	47E382553G1	36.000	36.000	000367

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE APPLY	P T C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT								
47C381088P22	WASHER				B	0000	EA	47E382553G1	36.000	36.000	000369
47C381088P5	WASHER, 1.25 DIA				B	0000	EA	47E382363G1	12.000	12.000	000333
47C381088P5	WASHER, 1.25 DIA				B	0000	EA	47E382441G1	240.000	240.000	000201
47C381088P5	WASHER, 1.25 DIA				B	0000	EA	47E382496G1	08.000	08.000	001271
47C381088P5	WASHER, 1.25 DIA				B	0000	EA	47E382602G1	16.000	16.000	000168
										276.000	
47C381088P6	WASHER, 1.25 DIA				B	0000	EA	47E382363G1	12.000	12.000	000347
47C381088P6	WASHER, 1.25 DIA				B	0000	EA	47E382603G1	24.000	48.000	000242
47C381088P6	WASHER, 1.25 DIA				B	0000	EA	47E382603G2	24.000	48.000	000270
										108.000	
47C381088P9	WASHER, 1.50 DIA				M	0000	EA	47D382598G1	24.000	24.000	000545
47C381088P9	WASHER, 1.50 DIA				M	0000	EA	47E382363G1	136.000	136.000	000334
47C381088P9	WASHER, 1.50 DIA				M	0000	EA	47E382441G1	72.000	72.000	000197
47C381088P9	WASHER, 1.50 DIA				M	0000	EA	47E382607G1	96.000	96.000	001281
47C381088P9	WASHER, 1.50 DIA				M	0000	EA	47E382608G1	68.000	68.000	001293
										396.000	
47E381089P1	TRAILING EDGE INSTL				M	0000	EA	47E382590G1	02.000	02.000	001008
47E381089P2	TRAILING EDGE INSTL				M	0000	EA	47E382590G1	02.000	02.000	001009
47E381089P3	TRAILING EDGE INSTL				M	0000	EA	47E382590G1	02.000	02.000	001010
47J381090P1	INNER BLADE SECTION				M	0000	EA	47E382590G1	02.000	02.000	001006
47D381091P1	ICE DETECTOR				M	0000	EA	47E382469G1	02.000	04.000	001071
47E381093P1	BGR THRUST TEETER				M	0000	EA	47E382605G1	02.000	02.000	001198
47J381097P1	OUTER BLADE SECTION				M	0000	EA	47E382590G1	02.000	02.000	001007
47B381099PAR	WIRE,AWG 30,SLDRLESS				B	0000	FT	47D387113G1	AR		001776
47B381099PAR	WIRE,AWG 30,SLDRLESS				B	0000	FT	47E387037G1	AR		000698
										00.000	
47E381100P1	CABINET				M	0000	EA	47E387062G1	01.000	01.000	000554
47D381101P1	SHRINK DISC				M	0000	EA	47E382605G1	02.000	02.000	001200
47C381102P1	ROTOR SEAL FWD				M	0000 03668	EA	47E382441G1	02.000	02.000	000189
47C381103P1	ROTOR SEAL AFT				M	0000 03668	EA	47E382441G1	02.000	02.000	000190
47C381104P1	STUD				M	0000	EA	47E382441G1	120.000	120.000	000192
47C381104P2	STUD				M	0000	EA	47E382441G1	120.000	120.000	000193

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E381105G1	BOLSTER ASSY			M	0000	EA		47E382590G1	01.000	01.000	000985
47B381106P1	"O" RING SEAL, AFT			M	0000	EA		47E382441G1	01.000	01.000	000181
47E381107P1	TROLLEY ASSY			M	0000	EA		47E382165G1	02.000	02.000	000034
47B381108P1	SENSOR, ROTOR SPEED			M	0000	81692 EA		47E382498G1	02.000	02.000	001276
47B381109P1	WSHR, BELLEVILLE SPR			B	0000	92830 EA		47E382441G1	120.000	120.000	000199
47C381110P1	SEAL, FWD, COUPLING			M	0000	EA		47E382601G1	04.000	04.000	000214
47C381111P1	BELLOWS JOINT			M	0000	EA		47E382599G1	01.000	01.000	001238
47E381112G1	FOUNDATION REQ'T			M	0000	EA		47E382297G1	01.000	01.000	000006
47E381112P1	FOUNDATION ASSEMBLY			M	0000	EA		47E381112G1	01.000	01.000	000007
47E381112P10	#11 REINFORCING ROD			M	0000	FT		47E381112G1	AR		000016
47E381112P3	NUT			B	0000	EA		47E381112G1	192.000	192.000	000009
47E381112P5	RECT. WIREWAY			M	0000	EA		47E381112G1	03.000	03.000	000011
47E381112P6	CONDUIT SECTION			M	0000	EA		47E381112G1	01.000	01.000	000012
47E381112P7	CONDUIT SECTION			M	0000	EA		47E381112G1	02.000	02.000	000013
47E381112P8	CONDUIT SECTION			M	0000	EA		47E381112G1	01.000	01.000	000014
47E381112P9	#09 REINFORCING ROD			M	0000	FT		47E381112G1	AR		000015
47E381113P1	FAIRING ENVELOPE			B	0000	EA		47D382606G1	01.000	01.000	000378
47D381114P1	BRG,RADIAL-TEETER			M	0000	EA		47E382583G1	01.000	02.000	001195
47C381115P1	ACTUATOR			B	0000	EA		47E382610G1	06.000	12.000	001025
47D382000	TOWER GEOMETRY/DIAG			X	0000	EA		47E382304G1	X		001873
47C382020	LUBRICATION SCHEM			X	0000	EA		47E382570G1	X		000535
47E382045	GEOMETRY ENVELOPE			X	0000	EA		47E382304G1	X		001307
47E382050P1	YAW HSG STRUCT,UPPER			M	0000	EA		47E382133G1	01.000	01.000	000023
47B382131P1	ENCLOSURE, DOOR			*	0000	EA		47D382430G1	01.000	02.000	000396
47B382131P1	ENCLOSURE, DOOR			*	0000	EA		47D382430G2	01.000	02.000	000404
47B382131P1	ENCLOSURE, DOOR			*	0000	EA		47D382474G1	01.000	01.000	000413

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT	PL-LATE APPLY	TIME						
47B382131P1	ENCLOSURE, DOOR			*	0000	EA	47D382474G2		01.000	01.000 06.000	000421
47E382133G1	YAW STRUCTURE ASSY			M	0000	EA	47D382593G1		01.000	01.000	000022
47E382165G1	YAW DRIVE INSTL			M	0000	EA	47D382593G1		01.000	01.000	000030
47C382181P1	TRACK MTG BRACKET			M	0000	EA	47E382165G1		04.000	04.000	000033
47C382181P2	TRACK, MTG BRACKET			M	0000	EA	47E382165G1		02.000	02.000	000063
47D382192P1	BRAKE MTG PLATE			M	0000	EA	47E382165G1		02.000	02.000	000041
47B382193P1	PIN, CLEVIS - BRAKE			M	0000	EA	47E382165G1		04.000	04.000	000044
47B382196P1	SPACER, CLEVIS BLOCK			M	0000	EA	47E382165G1		04.000	04.000	000061
47B382196P2	SPCR, ACTUATOR CLEVIS			M	0000	EA	47E382165G1		08.000	08.000	000062
47D382198P1	CLEVIS BLOCK			M	0000	EA	47E382165G1		02.000	02.000	000042
47D382198P2	CLEVIS BLOCK			M	0000	EA	47E382165G1		02.000	02.000	000064
47B382200P1	RETAINER, PIN			M	0000	EA	47E382165G1		04.000	04.000	000043
47E382219P1	YAW HSG STRUCT, LOWER			M	0000	EA	47E382133G1		01.000	01.000	000024
47C382234P1	GASKET			M	0000	EA	47E387062G1		02.000	02.000	000565
47B382248P1	AIR BAF, RIGHT SIDE			M	0000	EA	47E387062G1		01.000	01.000	000573
47B382248P2	AIR BAF, LEFT SIDE			M	0000	EA	47E387062G1		01.000	01.000	000574
47E382264P1	SIDE SUPPORT, WLDMT			M	0000	EA	47E382363G1		01.000	01.000	000361
47E382265P1	SIDE SUPPORT			M	0000	EA	47E382363G1		01.000	01.000	000320
47E382265P2	SIDE SUPPORT			M	0000	EA	47E382363G1		01.000	01.000	000321
47E382271P1	ROTOR ADAPTER, WLDMT			M	0000	EA	47E382363G1		01.000	01.000	000362
47E382272P1	ROTOR ADAPTER STRL			M	0000	EA	47E382363G1		01.000	01.000	000323
47D382274	NACELLE GEOMETRY			X	0000	EA	47E382304G1		X		001874
47B382277P1	DRIP TROUGH			M	0000	EA	47E382165G1		02.000	02.000	000069
47B382277P2	DRIP TROUGH			M	0000	EA	47E382165G1		02.000	02.000	000070

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---			P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT	APPLY								
47C382278P1	MANIFOLD FITTING				M	0000		EA	47E382165G1	02.000	02.000	000065
47A382285	PROFILE COORDINATES				X	0000		EA	47E382590G1	X		001228
47J382287P1	CENTER BLADE SECT				M	0000		EA	47E382590G1	01.000	01.000	000984
47D382288	GENERAL SITE LCTN				X	0000		EA	47E382304G1	X		001870
47D382296P1	LOW SPEED SHAFT				*	0000		EA	47D382435G1	01.000	01.000	000209
47E382297G1	TWR/FOUNDATION INSTL				M	0000		EA	47D382356G1	01.000	01.000	000003
47E382297P7	GROUT				M	0000		LB	47E382297G1	AR		000020
47D382298	SITE PLAN-1ST UNIT				X	0000		EA	47E382304G1	X		001871
47E382301P1	BOLSTER				M	0000		EA	47E381105G1	02.000	02.000	000986
47E382303P1	TWR/ FDN PLATF REQ				M	0000		EA	47E382297G1	01.000	01.000	000017
47E382304G1	WTG ASSY, MOD-5A		1		M	0000		EA			01.000	000001
47E382306G1	BED PL.,MACH.&DRILL.	01			M	0000		EA	47E382363G1	01.000	01.000	000304
47J382313G1	HYDR PIPING, YAW DR				M	0000		EA	47D382593G1	01.000	01.000	000075
47E382314	HYDRAULIC SYS SCHEM				X	0000		EA	47J382313G1	X		000105
47J382330G1	BLADE HYDRAULIC INST				M	0000		EA	47E382590G1	01.000	01.000	001122
47J382330P1	TUBING HYDRAULIC				M	0000		FT	47J382330G1	720.000	720.000	001123
47J382330P2	TUBING HYDRAULIC				M	0000		FT	47J382330G1	480.000	480.000	001124
47E382333P1	SPINDLE SHAFT				M	0000		EA	47E382441G1	01.000	01.000	000177
47E382334P1	TIP, BLADE				M	0000		EA	47E382582G1	02.000	04.000	001053
47C382335P1	TUBE ADAPTER				M	0000		EA	47J382330G1	04.000	04.000	001140
47C382335P2	TUBE ADAPTER				M	0000		EA	47J382330G1	06.000	06.000	001139
47C382336G1	BRKT, CLAMP MODIFIED				M	0000		EA	47J382330G1	38.000	38.000	001131
47C382336G2	BRKT, CLAMP MODIFIED				M	0000		EA	47J382330G1	08.000	08.000	001134
47C382336G3	BRKT, CLAMP				M	0000		EA	47J382330G1	06.000	06.000	001184
47C382336P1	BRACKET, ANGLE				M	0000		EA	47C382336G1	02.000	76.000	001132

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---				CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT	P T APPLY	C Y						
47C382336P1	BRACKET, ANGLE			M	0000		EA	47C382336G2	02.000	16.000	001135
47C382336P1	BRACKET, ANGLE			M	0000		EA	47C382336G3	02.000	12.000	001185
										104.000	
47C382337P1	ADAPTER, TUBE			M	0000		EA	47J382330G1	12.000	12.000	001145
47B382338P1	STUD, MOUNTING			M	0000		EA	47J382330G1	10.000	10.000	001142
47C382349P1	SLEEVE, SPLIT			M	0000		EA	47J382330G1	150.000	150.000	001149
47C382349P2	SLEEVE, SPLIT			M	0000		EA	47J382330G1	100.000	100.000	001150
47C382350P1	TEETER SPRT OUTER			M	0000		EA	47C382551G2	01.000	04.000	001000
47C382351P1	TEETER SPRT INNER			M	0000		EA	47C382551G1	01.000	04.000	000996
47D382352G1	TEETER ARM ASSY			M	0000		EA	47E382605G1	04.000	04.000	001204
47D382352P1	TEETER ARM			M	0000		EA	47D382352G1	01.000	04.000	001205
47D382352P2	RETAINING RING			M	0000		EA	47D382352G1	01.000	04.000	001206
47C382353P1	TEETER SUPPORT PIN			M	0000		EA	47E382605G1	04.000	04.000	001210
47E382355P1	TWR STRUCTURE ASSY			M	0000		EA	47E382297G1	01.000	01.000	000004
47D382356G1	TOWER ASSY, WTG			M	0000		EA	47E382304G1	01.000	01.000	000002
47E382357G1	BRACKET, INBOARD			M	0000		EA	47J382330G1	02.000	02.000	001127
47E382357P1	BRACKET			M	0000		EA	47E382357G1	01.000	02.000	001128
47D382358P1	BRKT, OUTBOARD			M	0000		EA	47J382330G1	02.000	02.000	001130
47C382359P1	PLATE			M M	0000		EA	47J382330G1	04.000	04.000	001165
47C382360G1	SUPPORT, HOSE			M	0000		EA	47J382330G1	02.000	02.000	001160
47C382360P1	PLATE			M	0000		EA	47C382360G1	01.000	02.000	001161
47C382360P2	PAD			M	0000		EA	47C382360G1	01.000	02.000	001162
47D382361G1	BASE, HOSE SUPPORT			M	0000		EA	47J382330G1	02.000	02.000	001155
47D382361P1	PLATE			M	0000		EA	47D382361G1	01.000	02.000	001156
47D382361P2	PAD			M	0000		EA	47D382361G1	01.000	02.000	001157
47E382363G1	NACELLE STRUCT ASSY	1		M	0000		EA	47E382597G1	01.000	01.000	000303

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47D382372P1	RTR BRG RETAINER,FWD			M	0000	EA	47E382441G1		01.000	01.000	000184
47B382373P1	SPACER			M	0000	EA	47J382330G1		08.000	08.000	001166
47B382373P2	SPACER			M	0000	EA	47J382330G1		08.000	08.000	001167
47B382373P3	SPACER			M	0000	EA	47J382330G1		08.000	08.000	001168
47C382390P1	PLUG, SHAFT TEETER			M	0000	EA	47D382397G1		02.000	02.000	000992
47B382396P1	SHIM,BRG			M	0000	EA	47E382605G1		02.000	02.000	001199
47B382396P1	SHIM,BRG			X	0000	EA	47E382608G1		X		001290
										02.000	
47D382397G1	TEETER PVT SFT ASSY			M	0000	EA	47D382550G1		01.000	01.000	000990
47D382397P1	TEETER PIVDT SHAFT			M	0000	EA	47D382397G1		01.000	01.000	000991
47B382398P1	SPACER			M	0000	EA	47E382413G1		AR		001082
47C382399P1	BLOCK,BALLAST			M	0000	EA	47E382413G1		96.000	96.000	001080
47E382400G1	LIGHTING PROT INSTL			M	0000	EA	47E382590G1		02.000	02.000	001106
47E382400P3	LIGHTING STRIP			M	0000	FT	47E382400G1		AR		001109
47E382400P4	SPLICE PLATE			M	0000	EA	47E382400G1		16.000	32.000	001110
47E382400P6	SHIM			M	0000	EA	47E382400G1		02.000	04.000	001112
47B382401P1	STUD			M	0000	EA	47E382413G1		32.000	32.000	001081
47E382403P1	INSERT,BOLSTER			M	0000	EA	47C382552G1		01.000	02.000	001004
47D382406	GEOMETRY DWG			X	0000	EA	47E382590G1		X		001225
47E382407P1	LOW SP BK SPRT BRKT			M	0000	EA	47E382495G1		01.000	02.000	001255
47E382413G1	BALLAST INSTL			M	0000	EA	47E382590G1		01.000	01.000	001079
47B382419P1	WASHER			B	0000	EA	47E382165G1		96.000	96.000	000050
47B382420P1	JAM NUT			B	0000	EA	47E382165G1		04.000	04.000	000056
47E382429P1	BED PL. STRUCT. WELD			M	0000	EA	47E382306G1		01.000	01.000	000305
47D382430G1	TRAP DR, BEDPL / TWR			M	0000	EA	47E382472G1		02.000	02.000	000389
47D382430G2	TRAP DR, BEDPL / TWR			M	0000	EA	47E382472G1		02.000	02.000	000398

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47D382430P1	COVER			M	0000		EA	47D382430G1	01.000	02.000	000390
47D382430P1	COVER			M	0000		EA	47D382430G2	01.000	02.000	000399
										04.000	
47D382430P2	ANGLE			M	0000		EA	47D382430G1	02.000	04.000	000391
47D382430P2	ANGLE			M	0000		EA	47D382430G2	02.000	04.000	000400
										08.000	
47D382430P3	ANGLE			M	0000		EA	47D382430G1	02.000	04.000	000392
47D382430P3	ANGLE			M	0000		EA	47D382430G2	02.000	04.000	000401
										08.000	
47D382430P4	RIB			M	0000		EA	47D382430G1	02.000	04.000	000393
47D382430P4	RIB			M	0000		EA	47D382430G2	02.000	04.000	000402
										08.000	
47D382430P5	PLATE			M	0000		EA	47D382430G1	01.000	02.000	000394
47D382430P6	BAR			M	0000		EA	47D382430G1	01.000	02.000	000395
47D382430P6	BAR			M	0000		EA	47D382430G2	01.000	02.000	000403
										04.000	
47D382435G1	LOW SPEED SHAFT ASSY			*	0000		EA	47E382601G1	01.000	01.000	000208
47C382436P1	SEAL RTNR, COUPLING			M	0000		EA	47E382601G1	02.000	02.000	000212
47C382437P1	SEAL PL, FWD CPLG			M	0000		EA	47E382601G1	06.000	06.000	000213
47E382440	SCHEM ROTOR HYDR SYS			X	0000		EA	47E382590G1		X	001227
47E382441G1	YOKE / SPINDLE ASSY			M	0000		EA	47E382601G1	01.000	01.000	000159
47E382450P1	GEARBOX MTG. STRUCT.			M	0000		EA	47E382306G1	01.000	01.000	000306
47B382454P1	ANTI-ROTATION PIN			M	0000		EA	47E382441G1	02.000	02.000	000183
47D382455P1	DISC, RTR SPEED SNSR			M	0000		EA	47E382441G1	01.000	01.000	000191
47D382456P1	RTR SEAL RTNR, AFT			M	0000		EA	47E382441G1	01.000	01.000	000182
47D382457P1	LOW SPEED BRAKE DISC			M	0000		EA	47E382441G1	01.000	01.000	000185
47C382458P1	RETAINER, AFT			M	0000		EA	47E382441G1	06.000	06.000	000180
47E382460	BLADE TOLERANCE DWG			X	0000		EA	47E382590G1		X	001226
47D382461P1	LOW SPEED BRAKE			M	0000		EA	47E382495G1	04.000	08.000	001256
47C382463G1	RING, MOUNTING			M	0000		EA	47C382464G1	02.000	08.000	001067

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---				CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT	P T APPLY	C Y						
47C382463P1	RING, MOUNTING				M	0000	EA	47C382463G1	02.000	08.000	001068
47C382464G1	RING & HOUSING ASSY				M	0000	EA	47E382469G1	02.000	04.000	001066
47C382464G1	RING & HOUSING ASSY				M	0000	EA	47E382469G2	02.000	04.000	001097
										08.000	
47D382465P1	FRAME, TRAP DOOR				M	0000	EA	47E382472G1	02.000	02.000	000423
47B382467P1	RETAINER				M	0000	EA	47E382469G1	02.000	04.000	001072
47B382467P2	RETAINER / COVER				M	0000	EA	47E382469G1	02.000	04.000	001075
47B382467P2	RETAINER / COVER				M	0000	EA	47E382469G2	02.000	04.000	001103
										08.000	
47B382468P1	GASKET				M	0000	EA	47E382469G1	02.000	04.000	001073
47E382469G1	ICE DETECTOR INSTL				M	0000	EA	47E382590G1	02.000	02.000	001065
47E382469G2	ICE DETECTOR INSTL				M	0000	EA	47E382590G1	02.000	02.000	001096
47B382470P1	GASKET, COVER				M	0000	EA	47E382469G1	02.000	04.000	001078
47B382470P1	GASKET, COVER				M	0000	EA	47E382469G2	02.000	04.000	001105
										08.000	
47E382472G1	LAD & FALSE FL INSTL				M	0000	EA	47E382597G1	01.000	01.000	000388
47E382472P11	SEALING STRIP				M	0000	EA	47E382472G1	AR		000429
47E382472P8	ROOF SCUTTLE				B	0000	EA	47E382472G1	01.000	01.000	000426
47D382474G1	TRAP DR, BEDPL / LUBE				M	0000	EA	47E382472G1	01.000	01.000	000406
47D382474G2	TRAP DR, BEDPL / LUBE				M	0000	EA	47E382472G1	01.000	01.000	000415
47D382474P1	COVER				M	0000	EA	47D382474G1	01.000	01.000	000407
47D382474P1	COVER				M	0000	EA	47D382474G2	01.000	01.000	000416
										02.000	
47D382474P2	ANGLE				M	0000	EA	47D382474G1	02.000	02.000	000408
47D382474P2	ANGLE				M	0000	EA	47D382474G2	02.000	02.000	000417
										04.000	
47D382474P3	ANGLE				M	0000	EA	47D382474G1	02.000	02.000	000409
47D382474P3	ANGLE				M	0000	EA	47D382474G2	02.000	02.000	000418
										04.000	
47D382474P4	RIB				M	0000	EA	47D382474G1	02.000	02.000	000410
47D382474P4	RIB				M	0000	EA	47D382474G2	02.000	02.000	000419
										04.000	

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IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---				CYCLE TIME	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT	P T APPLY	C Y							
47D382474P5	PLATE			M	0000		EA		47D382474G1	01.000	01.000	000411
47D382474P6	BAR			M	0000		EA		47D382474G1	01.000	01.000	000412
47D382474P6	BAR			M	0000		EA		47D382474G2	01.000	01.000	000420
											02.000	
47C382475P1	MOUNTING BLOCK			M	0000		EA		47E382472G1	02.000	02.000	000424
47B382480P1	BRACKET, SENSOR			M	0000		EA		47E382498G1	02.000	02.000	001275
47C382485P1	LIFTING, BRKT			M	0000		EA		47D382598G1	02.000	02.000	000543
47E382486P1	SIDE SUPPORT			M	0000		EA		47E382599G1	01.000	01.000	001235
47E382488P1	PRE-LOAD FIXTURE			M	0000		EA		47E382605G1	02.000	02.000	001213
47E382491G1	AIR DUCT UNIT			M	0000		EA		47E387062G1	02.000	02.000	000556
47D382492P1	NUT PLATE			M	0000		EA		47E382495G1	01.000	02.000	001259
47D382492P2	NUT PLATE			M	0000		EA		47E382495G1	02.000	04.000	001258
47D382492P3	NUT PLATE			M	0000		EA		47E382495G1	01.000	02.000	001260
47D382492P4	NUT PLATE			M	0000		EA		47E382495G1	02.000	04.000	001257
47D382493P1	NUT PLATE			M	0000		EA		47E382495G1	02.000	04.000	001262
47D382493P2	NUT PLATE			M	0000		EA		47E382495G1	01.000	02.000	001263
47D382493P3	NUT PLATE			M	0000		EA		47E382495G1	02.000	04.000	001261
47B382494P1	NUT PLATE			M	0000		EA		47E382495G1	08.000	16.000	001264
47E382495G1	LOW SP BK SPRT ASSY			M	0000		EA		47E382496G1	02.000	02.000	001254
47E382496G1	LOW SPEED BRAKE INST			M	0000		EA		47E382607G1	01.000	01.000	001253
47E382498G1	RTR SPEED SNSR INSTL			M	0000		EA		47E382607G1	01.000	01.000	001274
47C382499P1	TOWER ACCESS DOOR			M	0000		EA		47E382297G1	01.000	01.000	000005
47D382550G1	SFT, TEETER BRG ASSY			M	0000		EA		47E381105G1	01.000	01.000	000987
47D382550P1	CLOTH, FIBERGLASS			M	0000		FT		47D382550G1	AR		000988
47D382550P2	ADHESIVE			M	0000		OZ		47D382550G1	AR		000989
47C382551G1	TEETER RESTR ASSY			M	0000		EA		47E381105G1	04.000	04.000	000993

IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE APPLY	P T C Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT								
47C382551G2	TEETEER RESTR ASSY				M	0000	EA	47E381105G1	04.000	04.000	000997
47C382551P1	CLOTH, FIBERGLASS				M	0000	FT	47C382551G1	AR		000994
47C382551P1	CLOTH, FIBERGLASS				M	0000	FT	47C382551G2	AR	00.000	000998
47C382551P2	ADHESIVE, EPOXY				M	0000	OZ	47C382551G1	AR		000995
47C382551P2	ADHESIVE, EPOXY				M	0000	OZ	47C382551G2	AR	00.000	000999
47C382552G1	BOLSTER INSR ASSY				M	0000	EA	47E381105G1	02.000	02.000	001001
47C382552P1	CLOTH, FIBERGLASS				M	0000	FT	47C382552G1	AR		001002
47C382552P2	ADHESIVE				M	0000	OZ	47C382552G1	AR		001003
47E382553G1	GEARBOX INSTALLATION				M	0000	EA	47E382597G1	01.000	01.000	000363
47D382554P1	FLOORING, BEDPLATE				M	0000	EA	47E382306G1	01.000	01.000	000313
47D382555P1	LIFTING BRKT				M	0000	EA	47D382598G1	02.000	02.000	000544
47E382556G1	GEARBOX/CLG PLATFORM				M	0000	EA	47E382579G1	01.000	01.000	000444
47E382556P1	ANGLE, 4 X 4 X 3/8				M	0000	EA	47E382556G1	04.000	04.000	000445
47E382556P10	SIDE PLATE 4.0 HT				M	0000	EA	47E382556G1	02.000	02.000	000454
47E382556P11	ANGLE, 3 X 3 X 3/8				M	0000	EA	47E382556G1	04.000	04.000	000455
47E382556P12	ANGLE, 3 X 3 X 3/8				M	0000	EA	47E382556G1	04.000	04.000	000456
47E382556P13	ANGLE, 3 X 3 X 3/8				M	0000	EA	47E382556G1	02.000	02.000	000457
47E382556P14	ANGLE, 3 X 3 X 3/8				M	0000	EA	47E382556G1	02.000	02.000	000458
47E382556P2	CHANNEL, 8-20 LB				M	0000	EA	47E382556G1	02.000	02.000	000446
47E382556P3	CHANNEL, 6-16.3 LB				M	0000	EA	47E382556G1	04.000	04.000	000447
47E382556P4	ANGLE, 3X3-7.2 LB				M	0000	EA	47E382556G1	04.000	04.000	000448
47E382556P5	CHANNEL, 8-20 LB				M	0000	EA	47E382556G1	04.000	04.000	000449
47E382556P6	9-IN X 2 1/2 DP DECK				M	0000	EA	47E382556G1	14.000	14.000	000450
47E382556P7	6-IN X 2 1/2 DP DECK				M	0000	EA	47E382556G1	01.000	01.000	000451
47E382556P8	9-IN X 2 1/2 DP DECK				M	0000	EA	47E382556G1	01.000	01.000	000452

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E382556P9	END PLATE 4.0 HT			M	0000	EA		47E382556G1	02.000	02.000	000453
47C382557P1	ROTOR BRG SHIM			M	0000	EA		47E382441G1	04.000	04.000	000186
47B382558P1	INSERT, BRAKE DISC			M	0000	EA		47E382441G1	120.000	120.000	000187
47C382559P1	RTR SEAL RTNR, FWD			M	0000	EA		47E382441G1	01.000	01.000	000188
47C382560P1	PLUG, TORQUE PLATE			M	0000	EA		47E382441G1	02.000	02.000	000194
47D382563G1	TORQUE PLATE ASSY			M	0000	EA		47E382165G1	04.000	04.000	000035
47D382563P1	TORQUE PLATE			M	0000	EA		47D382563G1	01.000	04.000	000036
47B382564P1	BEARING ANGLE			M	0000	EA		47D382563G1	02.000	08.000	000037
47E382570G1	LUBE PLATFORM INSTL			M	0000	EA		47E382597G1	01.000	01.000	000442
47E382570P10	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000513
47E382570P11	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000514
47E382570P12	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000515
47E382570P13	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000516
47E382570P4	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000507
47E382570P5	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000508
47E382570P6	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000509
47E382570P7	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000510
47E382570P8	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000511
47E382570P9	PIPE ASSY			M	0000	EA		47E382570G1	01.000	01.000	000512
47E382571	LIFT REQT, TWR CMPNT			X	0000	EA		47D382356G1	X		000157
47D382572P1	SPACER, ADAPTER			M	0000	EA		47E382363G1	01.000	01.000	000338
47D382572P2	SPACER, ADAPTER			M	0000	EA		47E382363G1	01.000	01.000	000339
47D382572P3	SPACER, ADAPTER			M	0000	EA		47E382363G1	01.000	01.000	000340
47D382572P4	SPACER, ADAPTER			M	0000	EA		47E382363G1	01.000	01.000	000341
47D382572P5	SPACER, SIDE SUPPORT			M	0000	EA		47E382363G1	04.000	04.000	000342

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47D382572P6	SPACER, SIDE SUPPORT			M	0000	EA	47E382363G1		02.000	02.000	000343
47D382572P7	SPACER, SIDE SUPPORT			M	0000	EA	47E382363G1		02.000	02.000	000344
47D382574P1	TOP, STRL, FWD, WLDMT			M	0000	EA	47E382363G1		01.000	01.000	000360
47D382575P1	TOP STRUCTURE FWD			M	0000	EA	47E382363G1		01.000	01.000	000336
47D382576P1	TOP, STRL, AFT, WLDMT			M	0000	EA	47E382363G1		01.000	01.000	000359
47D382577P1	TOP STRUCTURE, AFT			M	0000	EA	47E382363G1		01.000	01.000	000322
47E382578P1	CRANE, MOUNTING STRL			M	0000	EA	47E382363G1		01.000	01.000	000337
47E382579G1	COOLING PLATFORM ASM			M	0000	EA	47E382570G1		01.000	01.000	000443
47E382579P16	PIPE, SCHED 40, 5-IN			M	0000	FT	47E382579G1		07.000	07.000	000483
47E382579P18	PIPE, SCHED 40			M	0000	FT	47E382579G1		90.000	90.000	000485
47E382579P24	PIPE, SCHED 40, 3IN			M	0000	FT	47E382579G1		05.000	05.000	000491
47B382580P1	SEAL, TOP STRUCTURE			M	0000	EA	47E382363G1		01.000	01.000	000351
47B382580P2	SEAL, TOP STRUCTURE			M	0000	EA	47E382363G1		01.000	01.000	000353
47B382580P3	SEAL, TOP STRUCTURE			M	0000	EA	47E382363G1		02.000	02.000	000354
47E382581P1	HUB, BRG - TEETER			M	0000	EA	47E382583G1		01.000	02.000	001196
47E382582G1	BLADE TIP ATCH ASSY			M	0000	EA	47E382590G1		02.000	02.000	001051
47E382582P10	ADHESIVE, EPOXY			B	0000	PT	47E382582G1		AR		001061
47E382582P11	GLASSFIBER CLOTH			B	0000	FT	47E382582G1		AR		001062
47E382583G1	TEETER HUB/BRG ASSY			M	0000	EA	47E382605G1		02.000	02.000	001194
47E382583P3	DOWEL PIN			M	0000	EA	47E382583G1		03.000	06.000	001197
47C382584G1	MOT/PUMP/CLR PLATF			M	0000	EA	47E382579G1		01.000	01.000	000464
47C382584P1	PLATE, BASE			M	0000	EA	47C382584G1		01.000	01.000	000465
47C382584P2	BEAM, 4 W 13#			M	0000	EA	47C382584G1		02.000	02.000	000466
47C382584P3	BEAM, 6 W 9#			M	0000	EA	47C382584G1		02.000	02.000	000467
47B382585P1	ANCHOR STUD			M	0000	EA	47E381112G1		96.000	96.000	000008

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47B382586P1	ANCHOR PLATE			M	0000	EA	47E381112G1		48.000	48.000	000010
47D382587P1	FLOATING MT BRACKET			M	0000	EA	47E382592G1		04.000	04.000	000152
47D382588P1	CROSS SPRT TOP STRL			M	0000	EA	47E382363G1		01.000	01.000	000352
47D382589G1	GEN & HS SFT INSTL			M	0000	EA	47E382597G1		01.000	01.000	000370
47E382590G1	ROTOR BLADE ASSY			M	0000	EA	47E382304G1		01.000	01.000	000983
47E382590P12	FIBERGLASS,CLOTH			B	0000	EA	47E382590G1		AR		001095
47E382590P23	ADHESIVE,EPOXY			B	0000	PT	47E382590G1		AR		001191
47D382591P1	STRUCTURE FRAME UNIT			M	0000	EA	47E382592G1		04.000	04.000	000149
47E382592G1	PERS ELEV/SUPT INSTL			M	0000	EA	47D382356G1		01.000	01.000	000146
47E382592P5	ANGLE SECTION			M	0000	EA	47E382592G1		20.000	20.000	000151
47D382593G1	YAW S/S ASSY			M	0000	EA	47D382356G1		01.000	01.000	000021
47E382594G1	YAW SLIP RING INSTL			M	0000	EA	47D382593G1		01.000	01.000	000107
47E382595G1	TWR PLATFORM INSTL			M	0000	EA	47D382356G1		01.000	01.000	000127
47D382596G1	AUX CRANE INSTL			M	0000	EA	47E382597G1		01.000	01.000	000373
47E382597G1	NACELLE OVERALL ASSY	1		M	0000	EA	47E382304G1		01.000	01.000	000302
47E382597G1	NACELLE OVERALL ASSY	1		X	0000	EA	47E382607G1		X		001230
										01.000	
47D382598G1	LFT BRACKETS INSTL			M	0000	EA	47E382597G1		01.000	01.000	000542
47D382598P8	SPACER,STA 227.5			M	0000	EA	47D382598G1		04.000	04.000	000550
47D382598P9	SPACER,STA 227.5			M	0000	EA	47D382598G1		02.000	02.000	000551
47E382599G1	SLIP RING INST			M	0000	EA	47E382607G1		01.000	01.000	001232
47E382599P10	CONDUIT 1.50 DIA			M	0000	EA	47E382599G1		06.000	06.000	001242
47E382599P19	ANGLES			M	0000	EA	47E382599G1		02.000	02.000	001251
47E382599P9	CONDUIT 2.00 DIA			M	0000	EA	47E382599G1		03.000	03.000	001241
47E382600P1	YOKE STRL,WELDMENT			M	0000	EA	47E382602G1		01.000	01.000	000161
47E382601G1	YOKE ASSY			M	0000	EA	47E382304G1		01.000	01.000	000158

IDENTIFICATION NO.	NOMENCLATURE	ECN		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E382601G1	YOKE ASSY			X	0000	EA		47E382607G1		X 01.000	001231
47E382601P27	GREASE			B	0000	LB		47E382601G1		AR	000300
47E382602G1	MACHINING ASSY, YOKE			M	0000	EA		47E382441G1	01.000	01.000	000160
47E382602P16	YOKE BRG CAP MACH			X	0000	EA		47E382602G1		X	000176
47E382602P2	YOKE BRG CAP			M	0000	EA		47E382605G1	02.000	02.000	001193
47E382602P3	BRACKET			M	0000	EA		47E382602G1	06.000	06.000	000163
47E382602P4	BRACKET			M	0000	EA		47E382602G1	01.000	01.000	000164
47E382602P5	BRACKET			M	0000	EA		47E382602G1	01.000	01.000	000165
47E382603G1	TEETER RSTR BK ASSY			M	0000	EA		47E382601G1	02.000	02.000	000215
47E382603G2	TEETER RSTR BK ASSY			M	0000	EA		47E382601G1	02.000	02.000	000243
47D382604G1	SHAFT ALIGNMENT FTG			M	0000	EA		47E382601G1	04.000	04.000	000288
47D382604P1	SHOE			M	0000	EA		47D382604G1	01.000	04.000	000289
47D382604P2	ADJUSTING SCREW			M	0000	EA		47D382604G1	01.000	04.000	000290
47D382604P3	BRACKET			M	0000	EA		47D382604G1	01.000	04.000	000291
47D382604P4	PIN,6.00-LG X.50 DIA			M	0000	EA		47D382604G1	02.000	08.000	000292
47D382604P9	PAD,NYLON			M	0000	EA		47D382604G1	02.000	08.000	000297
47E382605G1	TEETER BRG/RSTR INST			M	0000	EA		47E382590G1	01.000	01.000	001192
47E382605P19	PIN			M	0000	EA		47E382605G1	04.000	04.000	001219
47D382606G1	FAIRING INSTALLATION			M	0000	EA		47E382597G1	01.000	01.000	000377
47D382606P2	SEALING STRIP			M	0000	EA		47D382606G1		AR	000379
47D382606P3	ADHESIVE(SEE NOTE 4)			B	0000	EA		47D382606G1		AR	000380
47E382607G1	YOKE / NACELLE INSTL			M	0000	EA		47E382304G1	01.000	01.000	001229
47E382608G1	ROTOR BLADE INSTL			M	0000	EA		47E382304G1	01.000	01.000	001289
47D382609P1	YOKE BRG CAP,WLDMT			M	0000	EA		47E382602G1	02.000	02.000	000162

ORIGINAL DATA IS
OF POOR QUALITY

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E382610G1	AILERON INSTALLATION			M	0000	EA		47E382590G1	02.000	02.000	001011
47A387005	I&C SIGNAL LIST			X	0000	EA		47E382304G1	X		001869
47D387009P1	GROUNDING XFMR			M	0000	EA		47E387060G1	01.000	01.000	000964
47D387010P1	CURRENT XFMR			M	0000	EA		47E387060G1	06.000	06.000	000966
47D387011P1	POTENTIAL XFMR			M	0000	EA		47E387060G1	03.000	03.000	000967
47C387013P1	GROUNDING RESISTOR			M	0000	EA		47E387060G1	02.000	02.000	000965
47E387014	SCHEM,NACELLE,GEN			X	0000	EA		47E382304G1	X		001872
47E387018	POWER DISTBR SCHEM			X	0000	EA		47E387081G1	X		001859
47D387022	SCHEMATIC			X	0000	EA		47D387121G1	X		000876
47E387027G1	ASSY,WTG CONTROL PAN*			*	0000	EA		47E387112G1	01.000	01.000	001328
47D387028P1	PANEL,FRONT,WTG CONT*			*	0000	EA		47E387027G1	01.000	01.000	001329
47D387029P1	CONNECTOR PANEL, WTG*			*	0000	EA		47E387027G1	01.000	01.000	001330
47D387030	SCHEMATIC DIAGRAM EL*			X 5	0000	EA		47E387027G1	X		001369
47D387032G1	GEAR BOX SIGNAL COND*			*	0000	EA		47E387072G1	01.000	01.000	000683
47D387034G1	WIND SIGNAL CONDITIO*			*	0000	EA		47E387072G1	01.000	01.000	000684
47E387037G1	ASSY,SYN SIG COND BD			*	0000	EA		47E387072G1	02.000	02.000	000685
47D387038	SCHEMATIC			X	0000	EA		47E387037G1	X		000702
47A387039	WIRE LIST			X	0000	EA		47E387037G1	X		000687
47D387040G1	POWER SIGNAL CONDITI*			*	0000	EA		47E387072G1	01.000	01.000	000681
47D387043G1	SYNCRD TO CURRENT CO*			*	0000	EA		47E387072G1	02.000	02.000	000682
47E387060G1	HIGH VOLTAGE CG ASSY			M	0000	EA		47E382597G1	01.000	01.000	000962
47E387061	SCHEMATIC			X	0000	EA		47E387072G1	X		000778
47E387062G1	CONT ELEK CAB, (CEC)			M	0000	EA		47E382597G1	01.000	01.000	000553
47D387063P1	PANEL			M	0000	EA		47D387121G1	01.000	01.000	000857
47D387063P2	MOUNTING CHASIS			M	0000	EA		47D387121G1	01.000	01.000	000858

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E387064	SCHEMATIC			X	0000	EA		47E387062G1		X	000562
47E387064	SCHEMATIC			X	0000	EA		47E387095G1		X	000637
										00.000	
47E387065G1	PANEL, RIGHT SIDE			*	0000	EA		47E387062G1	01.000	01.000	000816
47E387065P1	PANEL, RIGHT SIDE			*	0000	EA		47E387065G1	01.000	01.000	000817
47E387069G1	HIGH V CG DRILL ASSY			M	0000	EA		47E387060G1	01.000	01.000	000963
47D387070G1	CENTER PANEL			*	0000	EA		47E387062G1	01.000	01.000	000582
47D387070P1	PANEL			*	0000	EA		47D387070G1	01.000	01.000	000583
47D387070P2	SPACER STRIP			*	0000	EA		47D387070G1	02.000	02.000	000584
47E387072G1	I&C SIG CONDITIONER			*	0000	EA		47E387062G1	01.000	01.000	000645
47D387073P1	PANEL, FRONT			*	0000	EA		47E387072G1	01.000	01.000	000646
47D387074P1	PANEL, RIGHT SIDE			*	0000	EA		47E387072G1	01.000	01.000	000647
47D387074P2	PANEL, LEFT SIDE			*	0000	EA		47E387072G1	01.000	01.000	000648
47C387075P1	PANEL, REAR			*	0000	EA		47E387072G1	01.000	01.000	000649
47B387076G1	MTG. BRACKET, CIRCUIT*			*	0000	EA		47E387072G1	02.000	02.000	000664
47B387076G2	MTG. BRACKET, CIRCUIT*			*	0000	EA		47E387072G1	02.000	02.000	000668
47B387076P1	BRACKET			*	0000	EA		47B387076G1	01.000	02.000	000665
47B387076P2	BRACKET			*	0000	EA		47B387076G2	01.000	02.000	000669
47B387078P1	SUPPORT ANGLE, CABLE			*	0000	EA		47E387072G1	01.000	01.000	000678
47B387079P1	MTG. BRACKET			*	0000	EA		47E387072G1	02.000	02.000	000679
47E387081G1	ELEC EQUIP BUILDING			M	0000	EA		47E382304G1	01.000	01.000	001308
47B387082P1	SHIELD			*	0000	EA		47E387072G1	01.000	01.000	000748
47B387082P1	SHIELD			*	0000	EA		47E387095G1	01.000	01.000	000611
										02.000	
47D387083G1	ASSY, MOTHER BD-SIGN*			*	0000	EA		47E387072G1	01.000	01.000	000651
47D387083P4	TERMINAL BLOCK			*	0000	EA		47D387083G1	01.000	01.000	000655
47D387083P5	TERMINAL BLOCK			*	0000	EA		47D387083G1	01.000	01.000	000656

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E387084G1	ASSY, STATUS PANEL			M	0000	EA	47E387112G1		01.000	01.000	001666
47E387084P2	PANEL, SIDE			B	0000	EA	47E387084G1		02.000	02.000	001668
47E387085G1	ASSY, UTILITY PANEL			M	0000	EA	47E387112G1		01.000	01.000	001544
47E387085P2	PANEL, SIDE			M	0000	EA	47E387085G1		02.000	02.000	001546
47B387086P1	ANGLE			*	0000	EA	47D387083G1		02.000	02.000	000653
47D387087G1	ASSY, COLOR CODED FL*			*	0000	EA	47E387072G1		07.000	07.000	000738
47A387088	WIRE LIST			X	0000	EA	47E387072G1		X		000770
47D387089G1	ASSY,MTR SIG CONDTNR			M	0000	EA	47E387084G1		05.000	05.000	001675
47D387089G1	ASSY,MTR SIG CONDTNR			M	0000	EA	47E387085G1		03.000	03.000	001553
47D387089G1	ASSY,MTR SIG CONDTNR			M	0000	EA	47E387091G1		03.000	03.000	001380
										11.000	
47E387090P1	DRILL & TRIM			*	0000	EA	47D387083G1		01.000	01.000	000652
47E387091G1	ASSY,GENERATOR PANEL			M	0000	EA	47E387112G1		01.000	01.000	001371
47E387091P2	PANEL, SIDE			B	0000	EA	47E387091G1		01.000	01.000	001373
47D387092	SCHEMATIC			X	0000	EA	47D387089G1		X		001682
47E387093G1	WIND TRANSLATOR			M	0000	EA	47E387062G1		01.000	01.000	000800
47E387095G1	CONTROLLER ASSY			M	0000	EA	47E387062G1		01.000	01.000	000589
47E387095P42	BUSHING, STRAIN RLF			M	0000	EA	47E387095G1		01.000	01.000	000631
47E387095P43	BUSHING, STRAIN RLF			M	0000	EA	47E387095G1		08.000	08.000	000632
47E387095P47	PLUG, SNAP OUT			M	0000	EA	47E387095G1		03.000	03.000	000636
47C387096G1	MTG BRACKET ASSY			M	0000	EA	47E387062G1		02.000	02.000	000824
47C387096P1	MTG BRACKET			M	0000	EA	47C387096G1		01.000	02.000	000825
47E387097	SCHEMATIC			X	0000	EA	47E387085G1		X		001637
47E387098P1	PANEL, FRONT			M	0000	EA	47E387085G1		01.000	01.000	001545
47C387099P1	PANEL, REAR			M	0000	EA	47E387085G1		01.000	01.000	001547
47D387100	SCHEMATIC			X	0000	EA	47D387113G1		X		001772

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47E387101	SCHEMATIC			X	0000	EA	47E387084G1		X		001812
47E387103	SCHEMATIC			X	0000	EA	47E387091G1		X		001514
47E387104P1	PANEL, FRONT			B	0000	EA	47E387084G1		01.000	01.000	001667
47E387105P1	PANEL, FRONT			B	0000	EA	47E387091G1		01.000	01.000	001372
47D387106P1	PANEL, REAR			B	0000	EA	47E387084G1		01.000	01.000	001669
47D387106P1	PANEL, REAR			B	0000	EA	47E387091G1		01.000	01.000	001374
										02.000	
47D387107P1	SGL CD FR.,MODIFIED			B	0000	EA	47E387084G1		01.000	01.000	001671
47D387107P1	SGL CD FR.,MODIFIED			B	0000	EA	47E387091G1		01.000	01.000	001376
										02.000	
47D387108P1	BRACKET, CARD FRAME			B	0000	EA	47E387084G1		01.000	01.000	001672
47D387108P1	BRACKET, CARD FRAME			B	0000	EA	47E387091G1		01.000	01.000	001377
										02.000	
47D387109G1	FRONT PANEL			M	0000	EA	47E387060G1		01.000	01.000	000971
47D387110P1	BUS BAR			M	0000	EA	47E387060G1		01.000	01.000	000969
47E387112G1	SYS DISPLAY PNL ASSY			M	0000	EA	47E387081G1		01.000	01.000	001326
47D387113G1	SECURITY ALARM BOARD			M	0000	EA	47E387084G1		01.000	01.000	001763
47D387113G1	SECURITY ALARM BOARD			M	0000	EA	47E387091G1		01.000	01.000	001464
										02.000	
47E387114	CONTROL SYSTEM SCHEM			X	0000	EA	47E382304G1		X		001865
47E387115P1	MOUNTING FRAME			M	0000	EA	47E387095G1		01.000	01.000	000590
47E387116P1	DRILL & TRIM			M	0000	EA	47D387089G1		03.000	11.000	001381
47D387121G1	ESD ELECT ASSY			M	0000	EA	47E387062G1		01.000	01.000	000856
47D387122	SCHEMATIC			X	0000	EA	47D387130G1		X		000903
47A387124	WIRE LIST			X	0000	EA	47E387095G1		X		000630
47A387125	WIRE LIST			X	0000	EA	47D387121G1		X		000869
47A387128	WIRE LIST			X	0000	EA	47D387130G1		X		000902
47D387129P1	PANEL			M	0000	EA	47D387130G1		01.000	01.000	000883
47D387129P2	MOUNTING CHASSIS			M	0000	EA	47D387130G1		01.000	01.000	000884

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		P T	CYCLE	FSCM	U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	PL-LATE OUT APPLY								
47D387130G1	"G" SWITCH TEST ELEK			M	0000		EA	47E387062G1	01.000	01.000	000882
47D387132G1	ICE DETECTOR ELEK			M	0000		EA	47E387062G1	01.000	01.000	000922
4HP	PLUG			B	0000	97576	EA	47J382313G1	03.000	03.000	000099
4PN-SS	NIPPLE, PIPE			B	0000	97576	EA	47J382313G1	03.000	03.000	000079
4PT-SS	TEE, PIPE			B	0000	97576	EA	47J382313G1	03.000	03.000	000081
41F2RO	RESISTOR, 2 OHM			M	0000	03615	EA	47D387130G1	01.000	01.000	000897
415G-14-1	TERMINAL			M	0000	17117	EA	47D387130G1	08.000	08.000	000886
427D-SIZE-4	ELBOW, LONG			B	0000	14959	EA	47E382570G1	06.000	06.000	000505
427D-SIZE-5	ELBOW, LONG			B	0000	14959	EA	47E382570G1	03.000	03.000	000506
44AO111-16-9	WIRE, AWG #16			B 5	0000	06090	FT	47E387027G1	AR		001364
44AO111-16-9	WIRE, AWG #16			B 5	0000	06090	FT	47E387062G1	AR		000957
44AO111-16-9	WIRE, AWG #16			B 5	0000	06090	FT	47E387072G1	AR		000775
										00.000	
44AO111-20-9	WIRE, AWG #20			B 5	0000	06090	FT	47D387121G1	AR		000874
44AO111-20-9	WIRE, AWG #20			B 5	0000	06090	FT	47D387130G1	AR		000915
44AO111-20-9	WIRE, AWG #20			B 5	0000	06090	FT	47E387062G1	AR		000958
										00.000	
44AO111-22-9	WIRE, #22 AWG			B 5	0000	06090	FT	47E387072G1	AR		000783
44AO111-24-9	WIRE, AWG 24			B 5	0000	06090	FT	47E387084G1	AR		001816
44AO111-24-9	WIRE, AWG 24			B 5	0000	06090	FT	47E387085G1	AR		001640
44AO111-24-9	WIRE, AWG 24			B 5	0000	06090	FT	47E387091G1	AR		001518
										00.000	
44AOB11-12-9	WIRE, AWG #12			B 5	0000	06090	FT	47E387062G1	AR		000956
4538K1	TFE SEALER, TEFLON			B	0000	39428	EA	47J382313G1	01.000	01.000	000076
4697-1032-SS-20	HEX M & F STANDOFF			M	0000	55566	EA	47E387062G1	12.000	12.000	000934
47-61-201-10	CAPTIVE SCREW			M	0000	94222	EA	47D387121G1	04.000	04.000	000861
47-61-201-10	CAPTIVE SCREW			M	0000	94222	EA	47D387130G1	04.000	04.000	000885
										08.000	
53451-1	RELAY			B 7	0000	18342	EA	47D387089G1	09.000	33.000	001595
5596A-8	TERMINAL BOARD			*	0000	75382	EA	47E387072G1	01.000	01.000	000750

WTG - MOD 5A

TOP DOWN

BREAK DOWN



LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC								
			INC	OUT	APPLY	C	Y	TIME				
00	47E382304G1	WTG ASSY, MOD-5A	1			M	0000	EA		1.00	-	000001
01	47D382356G1	TOWER ASSY, WTG				M	0000	EA	1.00	1.00	1-00	000002
02	47E382297G1	TWR/FOUNDATION INSTL				M	0000	EA	1.00	1.00	1-00	000003
03	47E382355P1	TWR STRUCTURE ASSY				M	0000	EA	1.00	1.00	1-00	000004
03	47C382499P1	TOWER ACCESS DOOR				M	0000	EA	1.00	1.00	2-00	000005
03	47E381112G1	FOUNDATION REQ'T				M	0000	EA	1.00	1.00	3-00	000006
04	47E381112P1	FOUNDATION ASSEMBLY				M	0000	EA	1.00	1.00	1-00	000007
04	47B382585P1	ANCHOR STUD				M	0000	EA	96.00	96.00	2-00	000008
04	47E381112P3	NUT				B	0000	EA	192.00	192.00	3-00	000009
04	47B382586P1	ANCHOR PLATE				M	0000	EA	48.00	48.00	4-00	000010
04	47E381112P5	RECT. WIREWAY				M	0000	EA	3.00	3.00	5-00	000011
04	47E381112P6	CONDUIT SECTION				M	0000	EA	1.00	1.00	6-00	000012
04	47E381112P7	CONDUIT SECTION				M	0000	EA	2.00	2.00	7-00	000013
04	47E381112P8	CONDUIT SECTION				M	0000	EA	1.00	1.00	8-00	000014
04	47E381112P9	#09 REINFORCING ROD				M	0000	FT	AR		9-00	000015
04	47E381112P10	#11 REINFORCING ROD				M	0000	FT	AR		10-00	000016
03	47E382303P1	TWR/ FDN PLATF REQ'T				M	0000	EA	1.00	1.00	4-00	000017
03	N214P58B	NUT 2 1/2 DIA.				B	0000	EA	96.00	96.00	5-00	000018
03	N402P58B	WASHER				B	0000	EA	96.00	96.00	6-00	000019
03	47E382297P7	GROUT				M	0000	LB	AR		7-00	000020
02	47D382593G1	YAW S/S ASSY				M	0000	EA	1.00	1.00	2-00	000021
03	47E382133G1	YAW STRUCTURE ASSY				M	0000	EA	1.00	1.00	1-00	000022
04	47E382050P1	YAW HSG STRUCT, UPPER				M	0000	EA	1.00	1.00	1-00	000023
04	47E382219P1	YAW HSG STRUCT, LOWER				M	0000	EA	1.00	1.00	2-00	000024
04	47D381002P1	BEARING, YAW				M	0000	EA	1.00	1.00	3-00	000025
04	47C381036P32	BOLT				M	0000	EA	144.00	144.00	4-00	000026
04	47C381087P13	NUT, FATIGUE RATED				B	0000	EA	144.00	144.00	5-00	000027
04	47C381088P13	WASHER, HARDENED STL				B	0000	EA	144.00	144.00	6-00	000028
04	47C381088P14	WASHER, HARDENED STL				B	0000	EA	144.00	144.00	7-00	000029
03	47E382165G1	YAW DRIVE INSTL				M	0000	EA	1.00	1.00	2-00	000030
04	47D381010P1	BRAKE ASSY				M	0000	EA	8.00	8.00	1-00	000031
04	47D381003P1	ACTUATOR, HYDRAULIC				M	0000	EA	4.00	4.00	2-00	000032
04	47C382181P1	TRACK MTG BRACKET				M	0000	EA	4.00	4.00	3-00	000033
04	47E381107P1	TROLLEY ASSY				M	0000	EA	2.00	2.00	4-00	000034
04	47D382563G1	TORQUE PLATE ASSY				M	0000	EA	4.00	4.00	5-00	000035
05	47D382563P1	TORQUE PLATE				M	0000	EA	1.00	4.00	1-00	000036
05	47B382564P1	BEARING ANGLE				M	0000	EA	2.00	8.00	2-00	000037
05	N23P25012B	SCREW, CAP				B	0000	EA	6.00	24.00	3-00	000038

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LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC OUT										
05	N400P13B	WASHER, PLAIN				B	0000	EA		6.00	24.00		4-00	000039
05	N406P43B	LOCKWASHER				B	0000	EA		6.00	24.00		5-06	000040
04	47D382192P1	BRAKE MTG PLATE				M	0000	EA		2.00	2.00		6-00	000041
04	47D382198P1	CLEVIS BLOCK				M	0000	EA		2.00	2.00		7-00	000042
04	47B382200P1	RETAINER, PIN				M	0000	EA		4.00	4.00		8-00	000043
04	47B382193P1	PIN, CLEVIS - BRAKE				M	0000	EA		4.00	4.00		9-00	000044
04	47C381036P15	BOLT, FATIGUE RATED				B	0000	EA		36.00	36.00		10-00	000045
04	47C381036P16	BOLT, FATIGUE RATED				B	0000	EA		12.00	12.00		11-00	000046
04	N733P33112B	SCREW, 12 POINT				B	0000	EA		12.00	12.00		12-00	000047
04	BLFR-22	SPHERICAL BEARING				B	0000	EA		4.00	4.00		13-00	81376 000048
04	DREM-20-080	ROD END BEARING				B	0000	EA		4.00	4.00		14-00	81376 000049
04	47B382419P1	WASHER				B	0000	EA		96.00	96.00		15-00	000050
04	N727P33040B	CAPSCREW				B	0000	EA		24.00	24.00		16-00	000051
04	N265P33B	LOCKNUT				B	0000	EA		32.00	32.00		17-00	000052
04	N265P34B	LOCKNUT				B	0000	EA		12.00	12.00		18-00	000053
04	N214P34B	HEX NUT				B	0000	EA		12.00	12.00		19-00	000054
04	N266P43B	LOCKNUT				B	0000	EA		48.00	48.00		20-00	000055
04	47B382420P1	JAM NUT				B	0000	EA		4.00	4.00		21-00	000056
04	N402AP17B	PLAIN WASHER, NARROW				B	0000	EA		64.00	64.00		22-00	000057
04	N402AP48B	PLAIN WASHER, REG.				B	0000	EA		24.00	24.00		23-00	000058
04	**47E382165-24	BOLT				B	0000	EA		24.00	24.00		24-00	000059
04	N22BP21016B	CAPSCREW				B	0000	EA		16.00	16.00		26-00	000060
04	47B382196P1	SPACER, CLEVIS BLOCK				M	0000	EA		4.00	4.00		27-00	000061
04	47B382196P2	SPCR, ACTUATOR CLEVIS.				M	0000	EA		8.00	8.00		28-00	000062
04	47C382181P2	TRACK, MTG BRACKET				M	0000	EA		2.00	2.00		29-00	000063
04	47D382198P2	CLEVIS BLOCK				M	0000	EA		2.00	2.00		30-00	000064
04	47C382278P1	MANIFOLD FITTING				M	0000	EA		2.00	2.00		31-00	000065
04	N22P25036B	CAPSCREW				B	0000	EA		8.00	8.00		32-00	000066
04	N402AP13B	PLAIN WASHER, NARROW				B	0000	EA		8.00	8.00		33-00	000067
04	N405P43B	LOCKWASHER - MEDIUM				B	5	0000	EA	8.00	8.00		34-00	000068
04	47B382277P1	DRIP TROUGH				M	0000	EA		2.00	2.00		35-00	000069
04	47B382277P2	DRIP TROUGH				M	0000	EA		2.00	2.00		36-00	000070
04	A100-4	TUBE FTG, MALE CONN.				B	0000	EA		4.00	4.00		37-00	97576 000071
04	A400-4	TUBE FTG, MALE ELBOW				B	0000	EA		16.00	16.00		38-00	97576 000072
04	700-4	TUBE FTG, TEE UNION				B	0000	EA		8.00	8.00		39-00	97576 000073
04	B7A17B	.250 O.D X .035 WALL				M	0000	FT		20.00	20.00		40-00	000074
03	47J382313G1	HYDR PIPING, YAW DR				M	0000	EA		1.00	1.00		3-00	000075
04	4538K1	TFE SEALER, TEFLON				B	0000	EA		1.00	1.00		1-00	39428 000076
04	**47J382313-2	ACCUMULATOR & V PKG				M	0000	EA		1.00	1.00		2-00	000077
04	**47J382313-3	YAW POWER UNIT				M	0000	EA		1.00	1.00		3-00	000078
04	4PN-SS	NIPPLE, PIPE				B	0000	EA		3.00	3.00		4-00	97576 000079
04	3043T18	"U" BOLT & NUTS				B	5	0000	EA	6.00	6.00		5-00	39428 000080
04	4PT-SS	TEE, PIPE				B	0000	EA		3.00	3.00		6-00	97576 000081
04	B7A17B-.035	TUBING, .250 OD				B	0000	FT		4.00	4.00		7-00	000082
04	B7A17B-.065	TUBING, .500 OD				B	0000	FT		200.00	200.00		8-00	000083
04	47C381075P1	HOSE ASSY				M	0000	EA		4.00	4.00		9-00	000084

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE INC OUT	P T C Y	CYCLE U/M TIME	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF	
			DWG INC	OUT								
04	47C381075P2	HOSE ASSY				M	0000	EA	4.00	4.00	10-00 ^A	000085
04	47B381074P1	HOSE ASSY				M	0000	EA	2.00	2.00	11-00	000086
04	C9612-3	PRESSURE, SWITCH				B	0000	EA	3.00	3.00	12-00 89326	000087
04	HP36GT	VALVE, .50 NPT				B	0000	EA	3.00	3.00	13-00 01029	000088
04	22617-8	O-RING				B	0000	EA	10.00	10.00	14-00 01276	000089
04	980-8-8SS	CONNECTOR, BULKHEAD				B	0000	EA	2.00	2.00	15-00 97576	000090
04	100-8-4SS	CONNECTOR, MALE				B	0000	EA	3.00	3.00	16-00 97576	000091
04	100-8-8SS	CONNECTOR, MALE				B	0000	EA	3.00	3.00	17-00 97576	000092
04	8TFN5S	NIPPLE				B	0000	EA	8.00	8.00	18-00 97576	000093
04	A400-8SS	ELBOW, MALE				B	0000	EA	8.00	8.00	19-00 97576	000094
04	A600-8SS	TEE BRANCH, MALE				B	0000	EA	3.00	3.00	20-00 97576	000095
04	140-8-4SS	ADAPTER, REDUCER				B	0000	EA	4.00	4.00	21-00 97576	000096
04	700-8SS	TEE, UNION				B	0000	EA	16.00	16.00	22-00 97576	000097
04	100C-8SS	TUBE CAP				B	0000	EA	4.00	4.00	23-00 97576	000098
04	4HP	PLUG				B	0000	EA	3.00	3.00	24-00 97576	000099
04	100025	CLAMP ASSY				B	0000	EA	5.00	5.00	25-00 55017	000100
04	100050	CLAMP ASSY				B	0000	EA	103.00	103.00	26-00 55017	000101
04	8PRC-SS	CONNECTOR, REDUCING				B	0000	EA	3.00	3.00	27-00 97576	000102
04	300H1-15CG-04-K	PRESSURE TRANSDUCER				B	0000	EA	3.00	3.00	28-00 89326	000103
04	N405P41B	LOCK WASHER				B 5	0000	EA	12.00	12.00	29-00	000104
04	47E382314	HYDRAULIC SYS SCHEM				X	0000	EA	X		30-00	000105
03	**47D382593-4	GREASE SHIELD INSTL				M	0000	EA	1.00	1.00	4-00	000106
03	47E382594G1	YAW SLIP RING INSTL				M	0000	EA	1.00	1.00	5-00	000107
04	47D381019P1	SLIP RNG UN YAW AXIS				M	0000	EA	1.00	1.00	1-00	000108
04	47E381017	YAW SR ELECT INTFC				X	0000	EA	X		2-00	000109
04	**47E382594-3	CROSS BEAM				M	0000	EA	2.00	2.00	3-00	000110
04	**47E382594-4	MOUNTING BRACKET				M	0000	EA	1.00	1.00	4-00	000111
04	**47E382594-5	SUPPORT ANGLE				M	0000	EA	4.00	4.00	5-00	000112
04	**47E382594-6	YAW ELEC&INSTR INSTL				M	0000	EA	1.00	1.00	6-00	000113
04	N22P35052B	HEX HD BOLT				B	0000	EA	24.00	24.00	7-00	000114
04	N22AP35040B	HEX HD BOLT				B	0000	EA	12.00	12.00	8-00	000115
04	N265P35B	LOCK NUT, 3/4 DIA.				*	0000	EA	24.00	24.00	9-00	000116
04	N402P18B	WASHER, 3/4 DIA.				B	0000	EA	36.00	36.00	10-00	000117
04	N22P39068B	HEX HD BOLT				B	0000	EA	8.00	8.00	11-00	000118
04	N265P39B	LOCK NUT - 1 DIA.				B 5	0000	EA	8.00	8.00	12-00	000119
04	N402P20B	WASHER				B	0000	EA	8.00	8.00	13-00	000120
04	MS20995C20	LOCK WIRE				B 5	0000	FT	AR		14-00	000121
04	650LR-HAB350	POWER DISTR CONN				B	0000	EA	14.00	14.00	15-00 11117	000122
04	600BE	EXTENDER				B	0000	EA	6.00	6.00	16-00 11117	000123
04	**47E382594-17	DRAW LINK				M	0000	EA	2.00	2.00	17-00	000124
03	**47D382593-6	BRG, AUTO LUBE INSTL				M	0000	EA	1.00	1.00	6-00	000125
02	**47D382356-3	ELEC WIRE WAY INSTL				M	0000	EA	1.00	1.00	3-00	000126
02	47E382595G1	TWR PLATFORM INSTL				M	0000	EA	1.00	1.00	4-00	000127
03	**47E382595-1	LOWER PLATFORM ASSY				M	0000	EA	1.00	1.00	1-00	000128

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC									
			INC	OUT	APPLY	C	Y	TIME					
03	**47E382595-2	MID PLATFORM ASSY				M	0000	EA		1.00	1.00	2-00	000129
03	**47E382595-3	UPR (YAW) PLATF ASSY				M	0000	EA		1.00	1.00	3-00	000130
03	**47E382595-4	STAIRWAY ASSY				M	0000	EA		1.00	1.00	4-00	000131
03	**47E382595-5	PRIMARY LADDER ASSY				M	0000	EA		1.00	1.00	5-00	000132
03	**47E382595-6	ALTN LADDER ASSY				M	0000	EA		1.00	1.00	6-00	000133
03	**47E382595-7	GUARDRAIL ASSY				M	0000	EA		1.00	1.00	7-00	000134
03	**47E382595-8	HGR CABLE ASSY - UPR				M	0000	EA		12.00	12.00	8-00	000135
03	**47E382595-9	HGR CABLE ASSY - LWR				M	0000	EA		6.00	6.00	9-00	000136
03	**47E382595-10	ACCESS COVER HATCH				M	0000	EA		1.00	1.00	10-00	000137
03	**47E382595-11	HGR CLEVIS FITTING				M	0000	EA		12.00	12.00	11-00	000138
03	**47E382595-12	BEARING PADS				M	0000	EA		12.00	12.00	12-00	000139
03	N22P350368	BLT, HEX HD, 3/4 DIA.				B	0000	EA		36.00	36.00	13-00	000140
03	N264P358	LOCKNUT, 3/4 DIA.				B	0000	EA		36.00	36.00	14-00	000141
03	N402P188	WASHER, 3/4 DIA.				B	0000	EA		36.00	36.00	15-00	000142
02	**47D382356-5	TWR INSTM INSTL				M	0000	EA		1.00	1.00	5-00	000143
02	**47D382356-6	TOWER MARKINGS				M	0000	EA		1.00	1.00	6-00	000144
02	**47D382356-7	GND WIRE WAY INSTL				M	0000	EA		1.00	1.00	7-00	000145
02	47E382592G1	PERS ELEV/SUPT INSTL				M	0000	EA		1.00	1.00	8-00	000146
03	**47E382592-1	LWR G TWR SECT ASSY				M	0000	EA		1.00	1.00	1-00	000147
03	**47E382592-2	UPR G TWR SECT ASSY				M	0000	EA		1.00	1.00	2-00	000148
03	47D382591P1	STRUCTURE FRAME UNIT				M	0000	EA		4.00	4.00	3-00	000149
03	15AS650	PERS ELEVATOR UNIT				M	0000	EA		1.00	1.00	4-00	000150
03	47E382592P5	ANGLE SECTION				M	0000	EA		20.00	20.00	5-00	000151
03	47D382587P1	FLOATING MT BRACKET				M	0000	EA		4.00	4.00	6-00	000152
03	N14P350608	HEX HD BOLT, 3/4 DIA.				B	0000	EA		16.00	16.00	7-00	000153
03	N265P358	LOCK NUT, 3/4 DIA.				*	0000	EA		16.00	16.00	8-00	000154
03	N402P188	WASHER, 3/4 DIA.				B	0000	EA		16.00	16.00	9-00	000155
03	PB34-414	PARA BLT, CONC ANCHOR				B	0000	EA		16.00	16.00	10-00	000156
02	47E382571	LIFT REQ, TWR CMPNT				X	0000	EA		X		9-00	000157
01	47E382601G1	YOKE ASSY				M	0000	EA		1.00	1.00	2-00	000158
02	47E382441G1	YOKE / SPINDLE ASSY				M	0000	EA		1.00	1.00	1-00	000159
03	47E382602G1	MACHINING ASSY, YOKE				M	0000	EA		1.00	1.00	1-00	000160
04	47E382600P1	YOKE STRL, WELDMNT				M	0000	EA		1.00	1.00	1-00	000161
04	47D382609P1	YOKE BRG CAP, WLDMT				M	0000	EA		2.00	2.00	2-00	000162
04	47E382602P3	BRACKET				M	0000	EA		6.00	6.00	3-00	000163
04	47E382602P4	BRACKET				M	0000	EA		1.00	1.00	4-00	000164
04	47E382602P5	BRACKET				M	0000	EA		1.00	1.00	5-00	000165
04	N500P12464C	PIN, TAPERED DOWEL #13				M	0000	EA		8.00	8.00	6-00	000166
04	47C381036P14	BOLT, FATIGUE RATED				B	0000	EA		16.00	16.00	7-00	000167
04	47C381088P5	WASHER, 1.25 DIA				B	0000	EA		16.00	16.00	8-00	000168
04	N405P528	LOCK WASHER				M	0000	EA		16.00	16.00	9-00	000169
04	47C381036P6	BOLT, FATIGUE RATED				B	0000	EA		20.00	20.00	10-00	000170

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C	Y					
04	47C381088P1	WASHER, 1.00 DIA					M	0000	EA	40.00	40.00	11-00	000171
04	47C381088P2	WASHER, 1.00 DIA					M	0000	EA	40.00	40.00	12-00	000172
04	47C381087P2	LOCKNUT					B	0000	EA	40.00	40.00	13-00	000173
04	47C381036P2	BOLT, FATIGUE RATED					B	0000	EA	20.00	20.00	14-00	000174
04	CHOCKFAST-ORANGE	GROUTING					B	0000	EA	AR		15-00	20420 000175
04	47E382602P16	YOKE BRG CAP MACH					X	0000	EA	X		16-00	000176
03	47E382333P1	SPINDLE SHAFT					M	0000	EA	1.00	1.00	2-00	000177
03	47D381080P1	TPR RLR BRG, SPDL/AFT					M	0000	EA	1.00	1.00	3-00	80657 000178
03	47D381081P1	TPR RLR BRG, SPDL/FWD					M	0000	EA	1.00	1.00	4-00	80657 000179
03	47C382458P1	RETAINER, AFT					M	0000	EA	6.00	6.00	5-00	000180
03	47B381106P1	"O" RING SEAL, AFT					M	0000	EA	1.00	1.00	6-00	000181
03	47D382456P1	RTR SEAL RTNR, AFT					M	0000	EA	1.00	1.00	7-00	000182
03	47B382454P1	ANTI-ROTATION PIN					M	0000	EA	2.00	2.00	8-00	000183
03	47D382372P1	RTR BRG RETAINER, FWD					M	0000	EA	1.00	1.00	9-00	000184
03	47D382457P1	LOW SPEED BRAKE DISC					M	0000	EA	1.00	1.00	10-00	000185
03	47C382557P1	ROTOR BRG SHIM					M	0000	EA	4.00	4.00	11-00	000186
03	47B382558P1	INSERT, BRAKE DISC					M	0000	EA	120.00	120.00	12-00	000187
03	47C382559P1	RTR SEAL RTNR, FWD					M	0000	EA	1.00	1.00	13-00	000188
03	47C381102P1	ROTOR SEAL FWD					M	0000	EA	2.00	2.00	14-00	03668 000189
03	47C381103P1	ROTOR SEAL AFT					M	0000	EA	2.00	2.00	15-00	03668 000190
03	47D382455P1	DISC, RTR SPEED SNSR					M	0000	EA	1.00	1.00	16-00	000191
03	47C381104P1	STUD					M	0000	EA	120.00	120.00	17-00	000192
03	47C381104P2	STUD					M	0000	EA	120.00	120.00	18-00	000193
03	47C382560P1	PLUG, TORQUE PLATE					M	0000	EA	2.00	2.00	19-00	000194
03	47D381082P2	TORQUE PLATE					M	0000	EA	1.00	1.00	20-00	000195
03	47C381036P24	BOLT, FATIGUE RATED					B	0000	EA	36.00	36.00	21-00	000196
03	47C381088P9	WASHER, 1.50 DIA					M	0000	EA	72.00	72.00	22-00	000197
03	47C381087P9	NUT					B	0000	EA	36.00	36.00	23-00	000198
03	47B381109P1	WSHR, BELLEVILLE SPR					B	0000	EA	120.00	120.00	24-00	92830 000199
03	47C381087P5	NUT					B	0000	EA	360.00	360.00	25-00	000200
03	47C381088P5	WASHER, 1.25 DIA					B	0000	EA	240.00	240.00	26-00	000201
03	N2800P2	FITTING, LUBE					B	0000	EA	4.00	4.00	27-00	000202
03	N733P25016B	SCREW, TWELVE-POINT					B	0000	EA	78.00	78.00	28-00	000203
03	N405P43B	LOCKWASHER - MEDIUM					B	5 0000	EA	78.00	78.00	29-00	000204
03	N5700P6053B	PLUG, PIPE					B	0000	EA	4.00	4.00	30-00	000205
03	N733P29024B	SCREW, TWELVE-POINT					B	0000	EA	36.00	36.00	31-00	000206
03	N405P45B	WASHER, LOCK					B	5 0000	EA	36.00	36.00	32-00	000207
02	47D382435G1	LOW SPEED SHAFT ASSY					*	0000	EA	1.00	1.00	2-00	000208
03	47D382296P1	LOW SPEED SHAFT					*	0000	EA	1.00	1.00	1-00	000209
03	47D381082P1	COUPLING HUB, FWD					*	0000	EA	1.00	1.00	2-00	000210
03	47C381083P1	COUPLING HUB, AFT					*	0000	EA	1.00	1.00	3-00	000211
02	47C382436P1	SEAL RTNR, COUPLING					M	0000	EA	2.00	2.00	3-00	000212
02	47C382437P1	SEAL PL, FWD CPLG					M	0000	EA	6.00	6.00	4-00	000213
02	47C381110P1	SEAL, FWD, COUPLING					M	0000	EA	4.00	4.00	5-00	000214
02	47E382603G1	TEETER RSTR BK ASSY					M	0000	EA	2.00	2.00	6-00	000215

LVL IDENTIFICATION NO.		NOMENCLATURE		----- ECN -----		DWG		PL-LATE P T CYCLE U/M		PL-QTY		EXT/TOT QTY		ITEM/		FSCM CROSS	
						INC OUT		APPLY C Y TIME						REF DESG		REF	
03	**47E382603-1	HOUSING WALL,LH						M	0000	EA	1.00	2.00	1-00			000216	
03	**47E382603-2	HOUSING WALL,RH						M	0000	EA	1.00	2.00	2-00			000217	
03	47D381010P2	BRAKE ASSY						M	0000	EA	2.00	4.00	3-00			000218	
03	**47E382603-4	HOUSING COVER						M	0000	EA	1.00	2.00	4-00			000219	
03	**47E382603-5	TEETER ARM						M	0000	EA	1.00	2.00	5-00			000220	
03	**47E382603-6	HOUSING COVER						M	0000	EA	2.00	4.00	6-00			000221	
03	**47E382603-7	OUTBD BELLOWS COVER						M	0000	EA	1.00	2.00	7-00			000222	
03	**47E382603-8	INBD BELLOWS COVER						M	0000	EA	1.00	2.00	8-00			000223	
03	**47E382603-9	ROLLER GUIDE ASSY						M	0000	EA	1.00	2.00	9-00			000224	
03	**47E382603-10	BRKT ASSY,LIMIT SW						M	0000	EA	1.00	2.00	10-00			000225	
03	**47E382603-11	BRKT,MTG,LIMIT SW						M	0000	EA	1.00	2.00	11-00			000226	
03	CR115GM101	SWITCH,LIMIT						B	0000	EA	1.00	2.00	12-00	02295		000227	
03	N14P21012B	SCREW,CAP,HEX HD						B	0000	EA	4.00	8.00	13-00			000228	
03	N405P111B	LOCKWASHER						B	0000	EA	4.00	8.00	14-00			000229	
03	N14P25016B	SCREW,HEX HD						B	0000	EA	34.00	68.00	15-00			000230	
03	N405P113B	LOCKWASHER						B	0000	EA	34.00	68.00	16-00			000231	
03	N14P29016B	SCREW HEX HD						B	0000	EA	2.00	4.00	17-00			000232	
03	N405P115B	LOCKWASHER						B	0000	EA	2.00	4.00	18-00			000233	
03	N14P35032B	SCREW,HEX HD						B	0000	EA	4.00	8.00	19-00			000234	
03	N405P118B	LOCKWASHER						B	0000	EA	4.00	8.00	20-00			000235	
03	N14P39048B	SCREW,HEX HD						B	0000	EA	10.00	20.00	21-00			000236	
03	N266P39B	LOCKNUT						B	0000	EA	10.00	20.00	22-00			000237	
03	47C381036P14	BOLT,FATIGUE RATED						B	0000	EA	12.00	24.00	23-00			000238	
03	47C381087P5	NUT						B	0000	EA	12.00	24.00	24-00			000239	
03	**47E382603-25	HYDR FLUID LINE ASSY						M	0000	EA	1.00	2.00	25-00			000240	
03	271	LOCKTITE						B	0000	EA	AR		26-00	05972		000241	
03	47C381088P6	WASHER,1.25 DIA						B	0000	EA	24.00	48.00	28-00			000242	
02	47E382603G2	TEETER RSTR BK ASSY						M	0000	EA	2.00	2.00	7-00			000243	
03	**47E382603-1	HOUSING WALL,LH						M	0000	EA	1.00	2.00	1-00			000244	
03	**47E382603-2	HOUSING WALL,RH						M	0000	EA	1.00	2.00	2-00			000245	
03	47D381010P2	BRAKE ASSY						M	0000	EA	2.00	4.00	3-00			000246	
03	**47E382603-4	HOUSING COVER						M	0000	EA	1.00	2.00	4-00			000247	
03	**47E382603-5	TEETER ARM						M	0000	EA	1.00	2.00	5-00			000248	
03	**47E382603-6	HOUSING COVER						M	0000	EA	2.00	4.00	6-00			000249	
03	**47E382603-7	OUTBD BELLOWS COVER						M	0000	EA	1.00	2.00	7-00			000250	
03	**47E382603-8	INBD BELLOWS COVER						M	0000	EA	1.00	2.00	8-00			000251	
03	**47E382603-9	ROLLER GUIDE ASSY						M	0000	EA	1.00	2.00	9-00			000252	
03	**47E382603-11	BRKT,MTG,LIMIT SW						M	0000	EA	1.00	2.00	11-00			000253	
03	CR115GM101	SWITCH,LIMIT						B	0000	EA	1.00	2.00	12-00	02295		000254	
03	N14P21012B	SCREW,CAP,HEX HD						B	0000	EA	4.00	8.00	13-00			000255	
03	N405P111B	LOCKWASHER						B	0000	EA	4.00	8.00	14-00			000256	
03	N14P25016B	SCREW,HEX HD						B	0000	EA	34.00	68.00	15-00			000257	
03	N405P113B	LOCKWASHER						B	0000	EA	34.00	68.00	16-00			000258	
03	N14P29016B	SCREW HEX HD						B	0000	EA	2.00	4.00	17-00			000259	
03	N405P115B	LOCKWASHER						B	0000	EA	2.00	4.00	18-00			000260	
03	N14P35032B	SCREW,HEX HD						B	0000	EA	4.00	8.00	19-00			000261	

LVL IDENTIFICATION NO.	NOMENCLATURE	INC	DWG	ECN			PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF	DESG	FSCM CROSS REF
				-----	OUT	APPLY											
03	N405P118B																
03	N14P39048B																
03	N266P39B																
03	47C381036P14																
03	47C381087P5																
03	**47E382603-25																
03	271																
03	**47E382603-27																
03	47C381088P6																
02	**47E382601-8																
02	**47E382601-9																
02	**47E382601-10																
02	**47E382601-11																
02	N22BP29020B																
02	N22BP25016B																
02	N402P15B																
02	N402P13B																
02	N22P39048B																
02	N402P20B																
02	N22P39052B																
02	N214P39B																
02	N22P45112B																
02	N402P22B																
02	N264P45B																
02	TA-30																
02	**47E382601-24																
02	47D382604G1																
03	47D382604P1																
03	47D382604P2																
03	47D382604P3																
03	47D382604P4																
03	N504P2264																
03	N504P2224																
03	N402P20B																
03	N402P81B																
03	47D382604P9																
03	A15B60B1																
02	**47E382601-26																
02	47E382601P27																
02	**47E382601-28																
01	47E382597G1																
02	47E382363G1																
03	47E382306G1																

IVI	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C Y	TIME					
04	47E382429P1	BED PL. STRUCT. WELD			M		0000	EA		1.00	1.00	1-00	000305
04	47E382450P1	GEARBOX MTG. STRUCT.			M		0000	EA		1.00	1.00	2-00	000306
04	47C381036P40	BOLT, STRUCT. 2-12			M		0000	EA		24.00	24.00	3-00	000307
04	47C381087P18	NUT 2-12			M		0000	EA		24.00	24.00	4-00	000308
04	47C381088P18	WASHER 2.00			B		0000	EA		24.00	24.00	5-00	000309
04	47C381036P4	BOLT, FATIGUE RATED			M		0000	EA		20.00	20.00	6-00	000310
04	47C381087P1	NUT			M		0000	EA		20.00	20.00	7-00	000311
04	47C381088P2	WASHER, 1.00 DIA			M		0000	EA		20.00	20.00	8-00	000312
04	47D382554P1	FLOORING, BEDPLATE			M		0000	EA		1.00	1.00	9-00	000313
04	N733P35040B	BOLT, STRUCT. .75-10			M		0000	EA		36.00	36.00	10-00	000314
04	N272P35	LOCKNUT .75-10			M		0000	EA		36.00	36.00	11-00	000315
04	N402P48B	WASHER .75			*		0000	EA		36.00	36.00	12-00	000316
04	A15F6C18	RTV SILICONE SEALANT			M		0000	DZ		AR		13-00	000317
04	47C381088P17	WASHER 2.00			M		0000	EA		24.00	24.00	14-00	000318
04	47C381088P1	WASHER, 1.00 DIA			M		0000	EA		20.00	20.00	15-00	000319
03	47E382265P1	SIDE SUPPORT			M		0000	EA		1.00	1.00	2-00	000320
03	47E382265P2	SIDE SUPPORT			M		0000	EA		1.00	1.00	3-00	000321
03	47D382577P1	TOP STRUCTURE, AFT			M		0000	EA		1.00	1.00	4-00	000322
03	47E382272P1	ROTOR ADAPTER STRL			M		0000	EA		1.00	1.00	5-00	000323
03	47C381036P2	BOLT, FATIGUE RATED			B		0000	EA		32.00	32.00	6-00	000324
03	47C381036P6	BOLT, FATIGUE RATED			B		0000	EA		60.00	60.00	7-00	000325
03	47C381036P20	BOLT, FATIGUE RATED			B		0000	EA		88.00	88.00	8-00	000326
03	47C381036P10	BOLT, FATIGUE RATED			B		0000	EA		12.00	12.00	9-00	000327
03	47C381036P25	BOLT, FATIGUE RATED			B		0000	EA		36.00	36.00	10-00	000328
03	47C381087P2	LOCKNUT			B		0000	EA		92.00	92.00	11-00	000329
03	47C381087P6	LOCKNUT			B		0000	EA		12.00	12.00	12-00	000330
03	47C381087P10	LOCKNUT			B		0000	EA		124.00	124.00	13-00	000331
03	47C381088P1	WASHER, 1.00 DIA			M		0000	EA		92.00	92.00	14-00	000332
03	47C381088P5	WASHER, 1.25 DIA			B		0000	EA		12.00	12.00	15-00	000333
03	47C381088P9	WASHER, 1.50 DIA			M		0000	EA		136.00	136.00	16-00	000334
03	90681A487	PIN, TAPER			B		0000	EA		6.00	6.00	17-00	39428 000335
03	47D382575P1	TOP STRUCTURE FWD			M		0000	EA		1.00	1.00	18-00	000336
03	47E382578P1	CRANE, MOUNTING STRL			M		0000	EA		1.00	1.00	19-00	000337
03	47D382572P1	SPACER, ADAPTER			M		0000	EA		1.00	1.00	20-00	000338
03	47D382572P2	SPACER, ADAPTER			M		0000	EA		1.00	1.00	21-00	000339
03	47D382572P3	SPACER, ADAPTER			M		0000	EA		1.00	1.00	22-00	000340
03	47D382572P4	SPACER, ADAPTER			M		0000	EA		1.00	1.00	23-00	000341
03	47D382572P5	SPACER, SIDE SUPPORT			M		0000	EA		4.00	4.00	24-00	000342
03	47D382572P6	SPACER, SIDE SUPPORT			M		0000	EA		2.00	2.00	25-00	000343
03	47D382572P7	SPACER, SIDE SUPPORT			M		0000	EA		2.00	2.00	26-00	000344
03	47C381088P2	WASHER, 1.00 DIA			M		0000	EA		105.00	105.00	27-00	000345
03	47C381088P10	WASHER, 1.50 DIA			B		0000	EA		136.00	136.00	28-00	000346
03	47C381088P6	WASHER, 1.25 DIA			B		0000	EA		12.00	12.00	29-00	000347
03	47C381036P26	BOLT, FATIGUE RATED			B		0000	EA		12.00	12.00	30-00	000348
03	47C381087P9	NUT			B		0000	EA		12.00	12.00	31-00	000349
03	47C381036P1	BOLT, FATIGUE RATED			B		0000	EA		14.00	14.00	32-00	000350
03	47B382580P1	SEAL, TOP STRUCTURE			M		0000	EA		1.00	1.00	33-00	000351

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF	
			INC	OUT										APPLY
03	47D382588P1	CROSS SPRT TOP STRL					M	0000	EA	1.00	1.00	34-00	000352	
03	47B382580P2	SEAL, TOP STRUCTURE					M	0000	EA	1.00	1.00	35-00	000353	
03	47B382580P3	SEAL, TOP STRUCTURE					M	0000	EA	2.00	2.00	36-00	000354	
03	N733P35040B	BOLT, STRUCT. .75-10					M	0000	EA	20.00	20.00	37-00	000355	
03	N733P35064B	BOLT, STRL					B	0000	EA	8.00	8.00	38-00	000356	
03	N402P18B	WASHER, 3/4 DIA.					B	0000	EA	56.00	56.00	39-00	000357	
03	N272P35	LOCKNUT .75-10					M	0000	EA	28.00	28.00	40-00	000358	
03	47D382576P1	TOP, STRL, AFT, WLDMT					M	0000	EA	1.00	1.00	41-00	000359	
03	47D382574P1	TOP, STRL, FWD, WLDMT					M	0000	EA	1.00	1.00	42-00	000360	
03	47E382264P1	SIDE SUPPORT, WLDMT					M	0000	EA	1.00	1.00	43-00	000361	
03	47E382271P1	ROTOR ADAPTER, WLDMT					M	0000	EA	1.00	1.00	44-00	000362	
02	47E382553G1	GEARBOX INSTALLATION					M	0000	EA	1.00	1.00	2-00	000363	
03	47E381046P1	GEARBOX ENVELOPE					B	0000	EA	1.00	1.00	1-00	000364	
03	NUMBER-14	TAPER PIN 6.00 LG					B	0000	EA	4.00	4.00	2-00	76054 000365	
03	47C381036P50	BOLT					B	0000	EA	36.00	36.00	3-00	000366	
03	47C381088P21	WASHER					B	0000	EA	36.00	36.00	4-00	000367	
03	47C381087P22	LOCKNUT					B	0000	EA	36.00	36.00	5-00	000368	
03	47C381088P22	WASHER					B	0000	EA	36.00	36.00	6-00	000369	
02	47D382589G1	GEN & HS SFT INSTL					M	0000	EA	1.00	1.00	3-00	000370	
03	**47D382589-1	GENERATOR					B	0000	EA	1.00	1.00	1-00	000371	
03	47D381078P1	HIGH SPEED SFT ASSY					B	0000	EA	1.00	1.00	2-00	000372	
02	47D382596G1	AUX CRANE INSTL					M	0000	EA	1.00	1.00	4-00	000373	
03	P20-10-30-20	CRANE					B	0000	EA	1.00	1.00	1-00	58811 000374	
03	N405P49B	LOCKWASHER					B	0000	EA	36.00	36.00	2-00	000375	
03	N22P36064B	BOLT					B	0000	EA	36.00	36.00	3-00	000376	
02	47D382606G1	FAIRING INSTALLATION					M	0000	EA	1.00	1.00	5-00	000377	
03	47E381113P1	FAIRING ENVELOPE					B	0000	EA	1.00	1.00	1-00	000378	
03	47D382606P2	SEALING STRIP					M	0000	EA	AR		2-00	000379	
03	47D382606P3	ADHESIVE(SEE NOTE 4)					B	0000	EA	AR		3-00	000380	
03	BN360-813-3	BLIND NUT ASSY					B	5	0000	EA	56.00	56.00	4-00	73197 000381
03	N24P29048C	SCREW, HEX HD					B	0000	EA	48.00	48.00	5-00	000382	
03	N405P15C	WASHER, LOCK					B	5	0000	EA	56.00	56.00	6-00	000383
03	N402P15C	WASHER 1/2 DIA					B	5	0000	EA	56.00	56.00	7-00	000384
03	N24P29024C	SCREW, HEX HD					B	0000	EA	8.00	8.00	8-00	000385	
03	**47D382606-9	WINT SENSOR MAST					M	0000	EA	2.00	2.00	9-00	000386	
02	**47E382597-6	ELECT EQUIP INSTL					M	0000	EA	1.00	1.00	6-00	000387	
02	47E382472G1	LAD & FALSE FL INSTL					M	0000	EA	1.00	1.00	7-00	000388	
03	47D382430G1	TRAP DR, BEDPL / TWR					M	0000	EA	2.00	2.00	1-00	000389	
04	47D382430P1	COVER					M	0000	EA	1.00	2.00	1-00	000390	

OF POOR QUALITY

IVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT	APPLY	C	Y	TIME						
04	47D382430P2	ANGLE				M		0000	EA		2.00	4.00	2-00	000391
04	47D382430P3	ANGLE				M		0000	EA		2.00	4.00	3-00	000392
04	47D382430P4	RIB				M		0000	EA		2.00	4.00	4-00	000393
04	47D382430P5	PLATE				M		0000	EA		1.00	2.00	5-00	000394
04	47D382430P6	BAR				M		0000	EA		1.00	2.00	6-00	000395
04	47B382131P1	ENCLOSURE, DOOR				*		0000	EA		1.00	2.00	7-00	000396
04	47C381030P1	HINGE, TRAP DOOR				*		0000	EA		1.00	2.00	8-00	000397
03	47D382430G2	TRAP DR, BEDPL / TWR				M		0000	EA		2.00	2.00	2-00	000398
04	47D382430P1	COVER				M		0000	EA		1.00	2.00	1-00	000399
04	47D382430P2	ANGLE				M		0000	EA		2.00	4.00	2-00	000400
04	47D382430P3	ANGLE				M		0000	EA		2.00	4.00	3-00	000401
04	47D382430P4	RIB				M		0000	EA		2.00	4.00	4-00	000402
04	47D382430P6	BAR				M		0000	EA		1.00	2.00	6-00	000403
04	47B382131P1	ENCLOSURE, DOOR				*		0000	EA		1.00	2.00	7-00	000404
04	47C381030P1	HINGE, TRAP DOOR				*		0000	EA		1.00	2.00	8-00	000405
03	47D382474G1	TRAP DR, BEDPL / LUBE				M		0000	EA		1.00	1.00	3-00	000406
04	47D382474P1	COVER				M		0000	EA		1.00	1.00	1-00	000407
04	47D382474P2	ANGLE				M		0000	EA		2.00	2.00	2-00	000408
04	47D382474P3	ANGLE				M		0000	EA		2.00	2.00	3-00	000409
04	47D382474P4	RIB				M		0000	EA		2.00	2.00	4-00	000410
04	47D382474P5	PLATE				M		0000	EA		1.00	1.00	5-00	000411
04	47D382474P6	BAR				M		0000	EA		1.00	1.00	6-00	000412
04	47B382131P1	ENCLOSURE, DOOR				*		0000	EA		1.00	1.00	7-00	000413
04	47C381030P1	HINGE, TRAP DOOR				*		0000	EA		1.00	1.00	8-00	000414
03	47D382474G2	TRAP DR, BEDPL / LUBE				M		0000	EA		1.00	1.00	4-00	000415
04	47D382474P1	COVER				M		0000	EA		1.00	1.00	1-00	000416
04	47D382474P2	ANGLE				M		0000	EA		2.00	2.00	2-00	000417
04	47D382474P3	ANGLE				M		0000	EA		2.00	2.00	3-00	000418
04	47D382474P4	RIB				M		0000	EA		2.00	2.00	4-00	000419
04	47D382474P6	BAR				M		0000	EA		1.00	1.00	6-00	000420
04	47B382131P1	ENCLOSURE, DOOR				*		0000	EA		1.00	1.00	7-00	000421
04	47C381030P1	HINGE, TRAP DOOR				*		0000	EA		1.00	1.00	8-00	000422
03	47D382465P1	FRAME, TRAP DOOR				M		0000	EA		2.00	2.00	5-00	000423
03	47C382475P1	MOUNTING BLOCK				M		0000	EA		2.00	2.00	6-00	000424
03	**47E382472-7	FALSE FLOOR				M		0000	EA		1.00	1.00	7-00	000425
03	47E382472P8	ROOF SCUTTLE				B		0000	EA		1.00	1.00	8-00	000426
03	**47E382472-9	LADDER, ROOF				M		0000	EA		1.00	1.00	9-00	000427
03	**47E382472-10	LADDER, TOWER				M		0000	EA		2.00	2.00	10-00	000428
03	47E382472P11	SEALING STRIP				M		0000	EA		AR		11-00	000429
03	N727P29016B	BOLT, STRUCTURAL				B		0000	EA		32.00	32.00	12-00	000430
03	N402P45B	WASHER				B		0000	EA		72.00	72.00	13-00	000431
03	N265P29B	NUT, SELF-LOCKING .50*				*		0000	EA		112.00	112.00	14-00	000432

LVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT	APPLY	C	Y	TIME					
03	N727P29036B	BOLT, STRUCTURAL				B	0000	EA		48.00	48.00	15-00	000433
03	91151A033	WASHER, BEVEL				B	0000	EA		40.00	40.00	16-00	39428 000434
03	N727P29052B	BOLT, STRUCTURAL				B	0000	EA		28.00	28.00	17-00	000435
03	**47E382472-18	BRACKET, LADDER				M	0000	EA		8.00	8.00	18-00	000436
03	**47E382472-19	BRACKET, LADDER				M	0000	EA		1.00	1.00	19-00	000437
03	**47E382472-20	BRACKET, LADDER				M	0000	EA		1.00	1.00	20-00	000438
03	**47E382472-21	BRACKET, LADDER				M	0000	EA		2.00	2.00	21-00	000439
03	N727P29028B	BOLT, STRUCTURAL				B	0000	EA		24.00	24.00	22-00	000440
03	A15F6C18	RTV SILICONE SEALANT				M	0000	OZ		AR		23-00	000441
02	47E382570G1	LUBE PLATFORM INSTL				M	0000	EA		1.00	1.00	8-00	000442
03	47E382579G1	COOLING PLATFORM ASM				M	0000	EA		1.00	1.00	1-00	000443
04	47E382556G1	GEARBOX/CLG PLATFORM				M	0000	EA		1.00	1.00	1-00	000444
05	47E382556P1	ANGLE, 4 X 4 X 3/8				M	0000	EA		4.00	4.00	1-00	000445
05	47E382556P2	CHANNEL, 8-20 LB				M	0000	EA		2.00	2.00	2-00	000446
05	47E382556P3	CHANNEL, 6-16.3 LB				M	0000	EA		4.00	4.00	3-00	000447
05	47E382556P4	ANGLE, 3X3-7.2 LB				M	0000	EA		4.00	4.00	4-00	000448
05	47E382556P5	CHANNEL, 8-20 LB				M	0000	EA		4.00	4.00	5-00	000449
05	47E382556P6	9-IN X 2 1/2 DP DECK				M	0000	EA		14.00	14.00	6-00	000450
05	47E382556P7	6-IN X 2 1/2 DP DECK				M	0000	EA		1.00	1.00	7-00	000451
05	47E382556P8	9-IN X 2 1/2 DP DECK				M	0000	EA		1.00	1.00	8-00	000452
05	47E382556P9	END PLATE 4.0 HT				M	0000	EA		2.00	2.00	9-00	000453
05	47E382556P10	SIDE PLATE 4.0 HT				M	0000	EA		2.00	2.00	10-00	000454
05	47E382556P11	ANGLE, 3 X 3 X 3/8				M	0000	EA		4.00	4.00	11-00	000455
05	47E382556P12	ANGLE, 3 X 3 X 3/8				M	0000	EA		4.00	4.00	12-00	000456
05	47E382556P13	ANGLE, 3 X 3 X 3/8				M	0000	EA		2.00	2.00	13-00	000457
05	47E382556P14	ANGLE, 3 X 3 X 3/8				M	0000	EA		2.00	2.00	14-00	000458
05	N22P28024B	SCREW, HEX HD, 1/2-13				B	0000	EA		130.00	130.00	15-00	000459
05	N405P15B	LOCKWASHER				B	0000	EA		130.00	130.00	16-00	000460
05	N214FP29B	NUT, HEX, 1/2-13				B	0000	EA		130.00	130.00	17-00	000461
05	1-700	CRIMPING TOOL				B	0000	EA		1.00	1.00	18-00	09098 000462
05	1-600	J-BOLT/NUT/WASHER				B	0000	EA		12.00	12.00	19-00	09098 000463
04	47C382584G1	MOT/PUMP/CLR PLATF				M	0000	EA		1.00	1.00	2-00	000464
05	47C382584P1	PLATE, BASE				M	0000	EA		1.00	1.00	1-00	000465
05	47C382584P2	BEAM, 4 W 13#				M	0000	EA		2.00	2.00	2-00	000466
05	47C382584P3	BEAM, 6 W 9#				M	0000	EA		2.00	2.00	3-00	000467
05	N22P33020B	SCREW, HEX HD				B	0000	EA		16.00	16.00	4-00	000468
05	N405P77B	LOCKWASHER				B	0000	EA		16.00	16.00	5-00	000469
04	350-SERIES-3DC	PUMP				B	0000	EA		1.00	1.00	3-00	59180 000470
04	326T-FRAME	MOTOR, TEFC				B	0000	EA		1.00	1.00	4-00	000471
04	N620B-SERIES-N600	COUPLING				B	0000	EA		1.00	1.00	5-00	89040 000472
04	OCS-2000D	OIL COOLER				B	0000	EA		3.00	3.00	6-00	67049 000473
04	89281/2F	CHECKVALVE, SWG, 125LB				B	0000	EA		1.00	1.00	7-00	63686 000474

ORIGINAL
OF POOR QUALITY

I	VL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/	FSCM	CROSS
				DWG	INC								REF		
				INC	OUT	APPLY	C	Y	TIME				DES	REF	
04		MODEL-400-D	FILTER,DUPLEX,4-IN				B	0000	EA		1.00	1.00	8-00	61424	000475
04		**47E382579-9	BASE,FILTER SUPPORT				M	0000	EA		1.00	1.00	9-00		000476
04		47C381084P1	VALVE,THERMO,AMOT				M	0000	EA		1.00	1.00	10-00		000477
04		47C381086P1	VALVE,RELIEF,4-IN				M	0000	EA		1.00	1.00	11-00		000478
04		FIG-258-32IN-LONG	SADDLE SUPPORT,4 IN				B	0000	EA		2.00	2.00	12-00	92959	000479
04		FIG-258-12.5IN-LONG	SADDLE SUPPORT,4 IN				B	0000	EA		1.00	1.00	13-00	92959	000480
04		FIG-277	PIPE ROLL & PLATE				B	0000	EA		1.00	1.00	14-00	92959	000481
04		105E-SIZE-4	TEE,FLANGED,250 LB				B	0000	EA		1.00	1.00	15-00	40475	000482
04		47E382579P16	PIPE,SCHED 40,5-IN				M	0000	FT		7.00	7.00	16-00		000483
04		290E-SIZE-5	FLANGE,SLIP-ON 300LB				B	0000	EA		2.00	2.00	17-00	40475	000484
04		47E382579P18	PIPE,SCHED 40				M	0000	FT		90.00	90.00	18-00		000485
04		290E-SIZE-4	FLANGE,SLIP-ON,300LB				B	0000	EA		12.00	12.00	19-00	40475	000486
04		264E-SIZE-4	TEE,STRAIGHT,300LB				B	0000	EA		4.00	4.00	20-00	40475	000487
04		264E-SIZE-4-X-3	TEE,REDUCING,300LB				B	0000	EA		3.00	3.00	21-00	40475	000488
04		260E-SIZE-4	ELBOW,STRAIGHT,300LB				B	0000	EA		10.00	10.00	22-00	40475	000489
04		1981/2E	UNION-3IN,300LB				B	0000	EA		6.00	6.00	23-00	40475	000490
04		47E382579P24	PIPE,SCHED 40,3IN				M	0000	FT		5.00	5.00	24-00		000491
04		FIG-268E-SIZE-3	ELBOW,STREET,300LB				B	0000	EA		6.00	6.00	25-00	40475	000492
04		260E-SIZE-4-X-3	ELBOW,REDUCING,300LB				B	0000	EA		3.00	3.00	26-00	40475	000493
04		N22P35056B	SCREW,HEX HD				B	0000	EA		120.00	120.00	27-00		000494
04		N405P48B	LOCKWASHER				B	0000	EA		120.00	120.00	28-00		000495
04		N214P35B	NUT				B	0000	EA		120.00	120.00	29-00		000496
04		N22P33036B	SCREW,HEX HD				B	0000	EA		8.00	8.00	30-00		000497
04		N405P47B	LOCKWASHER				B	0000	EA		50.00	50.00	31-00		000498
04		N214P33B	NUT				B	0000	EA		50.00	50.00	32-00		000499
04		N22P33032B	SCREW,HEX HD				B	0000	EA		10.00	10.00	33-00		000500
04		N402AP17B	PLAIN WASHER, NARROW				B	0000	EA		50.00	50.00	34-00		000501
04		N22P33020B	SCREW,HEX HD				B	0000	EA		40.00	40.00	35-00		000502
04		N22P29018B	SCREW,HEX HD				B	0000	EA		8.00	8.00	36-00		000503
04		N405P45B	WASHER, LOCK				B	5 0000	EA		8.00	8.00	37-00		000504
03		427D-SIZE-4	ELBOW, LONG				B	0000	EA		6.00	6.00	2-00	14959	000505
03		427D-SIZE-5	ELBOW, LONG				B	0000	EA		3.00	3.00	3-00	14959	000506
03		47E382570P4	PIPE ASSY				M	0000	EA		1.00	1.00	4-00		000507
03		47E382570P5	PIPE ASSY				M	0000	EA		1.00	1.00	5-00		000508
03		47E382570P6	PIPE ASSY				M	0000	EA		1.00	1.00	6-00		000509
03		47E382570P7	PIPE ASSY				M	0000	EA		1.00	1.00	7-00		000510
03		47E382570P8	PIPE ASSY				M	0000	EA		1.00	1.00	8-00		000511
03		47E382570P9	PIPE ASSY				M	0000	EA		1.00	1.00	9-00		000512
03		47E382570P10	PIPE ASSY				M	0000	EA		1.00	1.00	10-00		000513
03		47E382570P11	PIPE ASSY				M	0000	EA		1.00	1.00	11-00		000514
03		47E382570P12	PIPE ASSY				M	0000	EA		1.00	1.00	12-00		000515
03		47E382570P13	PIPE ASSY				M	0000	EA		1.00	1.00	13-00		000516
03		294E-SIZE-4	FLANGE,SLIP ON				B	0000	EA		14.00	14.00	14-00	14959	000517
03		294E-SIZE-5	FLANGE,SLIP ON				B	0000	EA		6.00	6.00	15-00	14959	000518
03		47C381039P1	EXPANSION JOINT				M	0000	EA		2.00	2.00	16-00		000519
03		47C381039P2	EXPANSION JOINT				M	0000	EA		1.00	1.00	17-00		000520
03		FIG-88-SIZE-4	U-BOLT				B	0000	EA		2.00	2.00	18-00	96723	000521
03		FIG-88-SIZE-5	U-BOLT				B	0000	EA		1.00	1.00	19-00	96723	000522

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LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C	Y					
03	91151A031	WASHER,BEVEL					B	0000	EA	4.00	4.00	20-00	39428 000523
03	91151A33	WASHER,BEVEL					B	0000	EA	2.00	2.00	21-00	39428 000524
03	FIG-9-SIZE-5	HANGER,PEAR					B	0000	EA	1.00	1.00	22-00	96723 000525
03	FIG-500-5/8-DIA	ROD,THREADED					B	0000	EA	1.00	1.00	23-00	96723 000526
03	N214P33B	NUT					B	0000	EA	2.00	2.00	24-00	000527
03	N727P35056B	BOLT,STRUCTURAL					B	0000	EA	200.00	200.00	25-00	000528
03	N405P48B	LOCKWASHER					B	0000	EA	200.00	200.00	26-00	000529
03	N214P35B	NUT					B	0000	EA	200.00	200.00	27-00	000530
03	N727P35048B	BOLT,STRUCTURAL					B	0000	EA	32.00	32.00	28-00	000531
03	N402P48B	WASHER .75					*	0000	EA	32.00	32.00	29-00	000532
03	N265P35B	LOCK NUT, 3/4 DIA.					*	0000	EA	32.00	32.00	30-00	000533
03	91151A036	WASHER,BEVEL					B	0000	EA	32.00	32.00	31-00	39428 000534
03	47C382020	LUBRICATION SCHEM					X	0000	EA		X	32-00	000535
02	**47E382597-9	ELECT WW & CND INSTL					M	0000	EA	1.00	1.00	9-00	000536
02	47C381036P20	BOLT, FATIGUE RATED					B	0000	EA	120.00	120.00	10-00	000537
02	47C381087P13	NUT, FATIGUE RATED					B	0000	EA	120.00	120.00	11-00	000538
02	47C381088P14	WASHER, HARDENED STL					B	0000	EA	120.00	120.00	12-00	000539
02	47C381088P13	WASHER, HARDENED STL					B	0000	EA	120.00	120.00	13-00	000540
02	A15F6C18	RTV SILICONE SEALANT					M	0000	OZ	AR		14-00	000541
02	47D382598G1	LFT BRACKETS INSTL					M	0000	EA	1.00	1.00	15-00	000542
03	47C382485P1	LIFTING,BRKT					M	0000	EA	2.00	2.00	1-00	000543
03	47D382555P1	LIFTING BRKT					M	0000	EA	2.00	2.00	2-00	000544
03	47C381088P9	WASHER, 1.50 DIA					M	0000	EA	24.00	24.00	3-00	000545
03	47C381087P9	NUT					B	0000	EA	24.00	24.00	4-00	000546
03	47C381036P24	BOLT,FATIGUE RATED					B	0000	EA	8.00	8.00	5-00	000547
03	47C381036P20	BOLT, FATIGUE RATED					B	0000	EA	8.00	8.00	6-00	000548
03	47C381036P22	BOLT,FATIGUE RATED					B	0000	EA	8.00	8.00	7-00	000549
03	47D382598P8	SPACER,STA 227.5					M	0000	EA	4.00	4.00	8-00	000550
03	47D382598P9	SPACER,STA 227.5					M	0000	EA	2.00	2.00	9-00	000551
03	47C381088P10	WASHER, 1.50 DIA					B	0000	EA	24.00	24.00	10-00	000552
02	47E387062G1	CONT ELEK CAB, (CEC)					M	0000	EA	1.00	1.00	16-00	000553
03	47E381100P1	CABINET					M	0000	EA	1.00	1.00	1-00	000554
03	47D381040P1	HEAT EXCHANGER					M	0000	EA	2.00	2.00	2-00	000555
03	47E382491G1	AIR DUCT UNIT					M	0000	EA	2.00	2.00	3-00	000556
03	NP136931-A1	SIGNATURE STRIP					B	5 0000	EA	1.00	1.00	4-00	000557
03	N530P405G	SCR,DR RD HD,#4 X.31					B	0000	EA	4.00	4.00	5-00	000558
03	NP-206417	NAMEPLATE					B	5 0000	EA	1.00	1.00	6-00	000559
03	47A380070P3	NPL, AN/REV STATUS					*	0000	EA	1.00	1.00	7-00	000560
03	47A380052	ELECTRICAL FAB. STD					X	5 0000	EA		X	8-00	000561
03	47E387064	SCHEMATIC					X	0000	EA		X	9-00	000562
03	**47E387062-10	WIRE LIST					X	0000	EA		X	10-00	000563
03	47A380046	CONT ELEK CAB SPEC					X	0000	EA		X	11-00	000564
03	47C382234P1	GASKET					M	0000	EA	2.00	2.00	12-00	000565
03	**47E387062-13	PANEL, REAR RIGHT					M	0000	EA	1.00	1.00	13-00	000566
03	**47E387062-14	PANEL, REAR LEFT					M	0000	EA	1.00	1.00	14-00	000567

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT										
03	47A381067P8	I/O TRACK					M	0000	EA		8.00	8.00	15-00	000568
03	47A381067P9	120 VAC TRK INP MDL					M	0000	EA		81.00	81.00	16-00	000569
03	47A381067P10	120 VAC TRK OUT MDL					M	0000	EA		47.00	47.00	17-00	000570
03	47A381067P31	TERMINATOR PLUG					M	0000	EA		1.00	1.00	18-00	000571
03	**47E387062-19	CABLE ASSY					M	0000	EA		3.00	3.00	19-00	000572
03	47B382248P1	AIR BAF, RIGHT SIDE					M	0000	EA		1.00	1.00	20-00	000573
03	47B382248P2	AIR BAF, LEFT SIDE					M	0000	EA		1.00	1.00	21-00	000574
03	47A381067P23	CABLE, I/O TRACK					M	0000	EA		1.00	1.00	22-00	000575
03	**47E387062-23	CABLE CLAMP SUPPORT					M	0000	EA		1.00	1.00	23-00	000576
03	**47E387062-24	CABLE CLAMP SUPPORT					M	0000	EA		1.00	1.00	24-00	000577
03	**47E387062-25	CABLE CLAMP SUPPORT					M	0000	EA		1.00	1.00	25-00	000578
03	47A381045PAR	CLAMP, LOOP-CUSHIONED					M	0000	EA	AR			26-00	000579
03	A-72FSCPS	CENTER PANEL SUPPORT					M	0000	EA		2.00	2.00	27-00	00843 000580
03	A-72RP24F5	RELAY RACK ANGLE					M	0000	EA		1.00	1.00	28-00	00843 000581
03	47D387070G1	CENTER PANEL					*	0000	EA		1.00	1.00	29-00	000582
04	47D387070P1	PANEL					*	0000	EA		1.00	1.00	1-00	000583
04	47D387070P2	SPACER STRIP					*	0000	EA		2.00	2.00	2-00	000584
04	SS-024-3-ZI	SELF CLINCHING FASTE*					*	0000	EA		29.00	29.00	3-00	46384 000585
04	S-832-3-ZI	SELF CLINCHING FASTE*					*	0000	EA		6.00	6.00	4-00	46384 000586
04	S-632-3-ZI	SELF CLINCHING FASTE*					B 5	0000	EA		28.00	28.00	5-00	46384 000587
03	**47E387062-30	CABLE RETAINER					M	0000	EA		1.00	1.00	30-00	000588
03	47E387095G1	CONTROLLER ASSY					M	0000	EA		1.00	1.00	31-00	000589
04	47E387115P1	MOUNTING FRAME					M	0000	EA		1.00	1.00	1-00	000590
04	47A381067P16	POWER SUPPLY					M	0000	EA		1.00	1.00	2-00	000591
04	47A381067P18	CHASSIS					M	0000	EA		2.00	2.00	3-00	000592
04	SS00-30	HDL,RND 30 SET-OFF					B	0000	EA		2.00	2.00	4-00	08730 000593
04	47A381067P1	CTL PROCESSING UNIT					M	0000	EA		1.00	1.00	5-00	000594
04	47A381067P17	CHASSIS INTERFACE					M	0000	EA		1.00	1.00	6-00	000595
04	47A381067P3	16K EXECUTIVE MEMORY					M	0000	EA		1.00	1.00	7-00	000596
04	47A381067P5	16K RAM MEMORY					M	0000	EA		1.00	1.00	8-00	000597
04	47A381067P4	12K PROM, 4K RAM MEM					M	0000	EA		1.00	1.00	9-00	000598
04	47A381067P2	ARITH. PROCESSING					M	0000	EA		1.00	1.00	10-00	000599
04	47A381067P15	ERROR DETECTOR					M	0000	EA		1.00	1.00	11-00	000600
04	47A381067P14	WATCHDOG TIMER					M	0000	EA		1.00	1.00	12-00	000601
04	47A381067P20	FILLER BLANK					M	0000	EA		15.00	15.00	13-00	000602
04	47A381067P11	12-BIT A/D CONVERTER					M	0000	EA		2.00	2.00	14-00	000603
04	47A381067P12	12-BIT SS ANLG INPUT					M	0000	EA		3.00	3.00	15-00	000604
04	47A381067P13	12-BIT ANALOG OUTPUT					M	0000	EA		2.00	2.00	16-00	000605
04	47A381067P6	TTY & EIA INTFC MDL					M	0000	EA		3.00	3.00	17-00	000606
04	47A381067P7	I/O SYS DRIVER MDL					M	0000	EA		1.00	1.00	18-00	000607
04	3596A-3	TERMINAL BOARD					*	0000	EA		1.00	1.00	19-00	75382 000608
04	MS3596A-XP-3-38C	MARKER STRIP					*	0000	EA		1.00	1.00	20-00	75382 000609
04	9083	SPACER, THREADED					*	0000	EA		2.00	2.00	21-00	83330 000610
04	47B387082P1	SHIELD					*	0000	EA		1.00	1.00	22-00	000611
04	24205	COMPOUND, (LOCKTITE)					*	0000	OZ	AR			23-00	05972 000612
04	74755	PRIMER					*	0000	OZ	AR			24-00	05972 000613

LVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG	PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT	APPLY	C	Y		TIME					
04	N153P13024	SCREW, PAN HD, #6-32				*	0000	EA			2.00	2.00	25-00	000614
04	N415P13	WASHER, LOCK, #6				*	0000	EA			4.00	4.00	26-00	000615
04	N400P37	WASHER, FL, #6				*	0000	EA			2.00	2.00	27-00	000616
04	N226P13	NUT, PLAIN HEX, #6-32				*	0000	EA			2.00	2.00	28-00	000617
04	N416P13	WSHR, LOCK, INTL T #6				*	0000	EA			2.00	2.00	29-00	000618
04	SFSW-10F-CP-G02NA	PAN-L-SCREW, #10-32				B	0000	EA			12.00	12.00	30-00	000619
04	N153P16006	SCR, PH, #10-32				*	0000	EA			4.00	4.00	31-00	000620
04	N415P19	WASHER, LOCK, #10				*	0000	EA			4.00	4.00	32-00	000621
04	DC-37P	CONNECTOR				B	0000	EA			4.00	4.00	33-00	71468 000622
04	3341-1L	JACK SOCKET KIT				*	0000	EA			4.00	4.00	34-00	52760 000623
04	CP700-51	CONN HOUSING KIT				B	0000	EA			9.00	9.00	35-00	19006 000624
04	9158	CABLE, 5TP				B	0000	FT			AR		36-00	07903 000625
04	9160	CABLE, 8TP				B	0000	FT			AR		37-00	07903 000626
04	8741	CABLE, 2TP				B	0000	FT			AR		38-00	07907 000627
04	8740	CABLE, 1TP				B	0000	FT			AR		39-00	07907 000628
04	47A381043PAR	SLEEVING, VINYL				*	0000	FT			AR		40-00	000629
04	47A387124	WIRE LIST				X	0000	EA			X		41-00	000630
04	47E387095P42	BUSHING, STRAIN RLF				M	0000	EA			1.00	1.00	42-00	000631
04	47E387095P43	BUSHING, STRAIN RLF				M	0000	EA			8.00	8.00	43-00	000632
04	AML31EBA4AC	SWITCH, PUSH BUTTON				B	0000	EA			1.00	1.00	44-00	91929 000633
04	AML76F10T01P	SWITCH GUARD				B 5	0000	EA			1.00	1.00	45-00	91929 000634
04	**47E387095-46	LENS (RESET)				M	0000	EA			1.00	1.00	46-00	000635
04	47E387095P47	PLUG, SNAP OUT				M	0000	EA			3.00	3.00	47-00	000636
04	47E387064	SCHEMATIC				X	0000	EA			X		48-00	000637
04	47A380052	ELECTRICAL FAB. STD				X 5	0000	EA			X		49-00	000638
04	NP-206417	NAMEPLATE				B 5	0000	EA			1.00	1.00	50-00	000639
04	47A380070P3	NPL, AN/REV STATUS				*	0000	EA			1.00	1.00	51-00	000640
04	SN60WRMAP2	SOLDER / QQ-S-571				B 5	0000	LB			AR		52-00	000641
04	47A381037P1	LACING TAPE				*	0000	FT			AR		53-00	000642
04	47A380071PAR	SLEEVING, SHRINK				*	0000	FT			AR		54-00	000643
03	**47E387062-32	TACHOMETER PANEL				M	0000	EA			1.00	1.00	32-00	000644
03	47E387072G1	I&C SIG CONDITIONER				*	0000	EA			1.00	1.00	33-00	000645
04	47D387073P1	PANEL, FRONT				*	0000	EA			1.00	1.00	1-00	000646
04	47D387074P1	PANEL, RIGHT SIDE				*	0000	EA			1.00	1.00	2-00	000647
04	47D387074P2	PANEL, LEFT SIDE				*	0000	EA			1.00	1.00	3-00	000648
04	47C387075P1	PANEL, REAR				*	0000	EA			1.00	1.00	4-00	000649
04	FCA4	HANDLE				B 5	0000	EA			2.00	2.00	5-00	08730 000650
04	47D387083G1	ASSY, MOTHER BD-SIGN*				*	0000	EA			1.00	1.00	6-00	000651
05	47E387090P1	DRILL & TRIM				*	0000	EA			1.00	1.00	1-00	000652
05	47B387086P1	ANGLE				*	0000	EA			2.00	2.00	2-00	000653
05	SN60WRMAP2	SOLDER / QQ-S-571				B 5	0000	LB			AR		3-00	000654
05	47D387083P4	TERMINAL BLOCK				*	0000	EA			1.00	1.00	4-00	000655
05	47D387083P5	TERMINAL BLOCK				*	0000	EA			1.00	1.00	5-00	000656
05	RC36-8542-5	RECEPTACLE				*	0000	EA			10.00	10.00	6-00	57856 000657
05	3432-4205	HEADER				*	0000	EA			10.00	10.00	7-00	52760 000658
05	N153P9010	SCREW, PAN HD #4-40X5*				*	0000	EA			20.00	20.00	8-00	000659

OF FOUR QUALITY

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LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE APPLY	P C	T Y	CYCLE TIME	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG INC	OUT									
05	N415P11	WASHER, LOCK, #4				*		0000	EA	20.00	20.00	9-00	000660
05	N226P9	NUT, HEX, #4-40				*		0000	EA	20.00	20.00	10-00	000661
05	AD34BS	RIVET				*		0000	EA	9.00	9.00	11-00	7707 000662
05	47A380052	ELECTRICAL FAB. STD				X	5	0000	EA		X	12-00	000663
04	47B387076G1	MTG. BRACKET,CIRCUIT*				*		0000	EA	2.00	2.00	7-00	000664
05	47B387076P1	BRACKET				*		0000	EA	1.00	2.00	1-00	000665
05	CLSS-032-3ZI	SELF CLINCHING FASTE*				*		0000	EA	1.00	2.00	3-00	46384 000666
05	CLS-832-3ZI	SELF CLINCHING FASTE*				*		0000	EA	2.00	4.00	4-00	46384 000667
04	47B387076G2	MTG. BRACKET,CIRCUIT*				*		0000	EA	2.00	2.00	8-00	000668
05	47B387076P2	BRACKET				*		0000	EA	1.00	2.00	2-00	000669
05	CLSS-032-3ZI	SELF CLINCHING FASTE*				*		0000	EA	1.00	2.00	3-00	46384 000670
05	CLS-832-3ZI	SELF CLINCHING FASTE*				*		0000	EA	2.00	4.00	4-00	46384 000671
04	HE215	POWER SUPPLY				B	5	0000	EA	1.00	1.00	9-00	18655 000672
04	PM345	POWER SUPPLY				*		0000	EA	1.00	1.00	10-00	18655 000673
04	RGR17-.250	GUIDE RAIL,CARD				*		0000	EA	4.00	4.00	11-00	57856 000674
04	051-64-002-41	GUIDE				B	5	0000	EA	20.00	20.00	12-00	57856 000675
04	NP-206417	NAMEPLATE				B	5	0000	EA	1.00	1.00	13-00	000676
04	47A380070P3	NPL, AN/REV STATUS				*		0000	EA	1.00	1.00	14-00	000677
04	47B387078P1	SUPPORT ANGLE,CABLE				*		0000	EA	1.00	1.00	15-00	000678
04	47B387079P1	MTG. BRACKET				*		0000	EA	2.00	2.00	16-00	000679
04	47B381059P4	CONNECTOR CUTOOT COV*				*		0000	EA	3.00	3.00	17-00	000680
04	47D387040G1	POWER SIGNAL CONDITI*				*		0000	EA	1.00	1.00	18-00	000681
04	47D387043G1	SYNCRD TO CURRENT CD*				*		0000	EA	2.00	2.00	19-00	000682
04	47D387032G1	GEAR BOX SIGNAL COND*				*		0000	EA	1.00	1.00	20-00	000683
04	47D387034G1	WIND SIGNAL CONDITIO*				*		0000	EA	1.00	1.00	21-00	000684
04	47E387037G1	ASSY,SYN SIG COND BD				*		0000	EA	2.00	2.00	22-00	000685
05	BB03-0501	BOARD				B		0000	EA	1.00	2.00	1-00	57856 000686
05	47A387039	WIRE LIST				X		0000	EA		X	2-00	000687
05	IC-308-WGG	SOCKET, 8-PIN				B		0000	EA	6.00	12.00	3-00	55322 000688
05	SC-1W3-GG	SOCKET				B		0000	EA	16.00	32.00	4-00	55322 000689
05	SC-1W1-GG-1	TERMINAL				B		0000	EA	15.00	30.00	5-00	55322 000690
05	DSS-C4	SWITCH COVER				M		0000	EA	1.00	2.00	6-00	95146 000691
05	AP-616-G-E	ADAPTER PLUG				M		0000	EA	2.00	4.00	7-00	55322 000692
05	BB248	TERMINAL				B		0000	EA	21.00	42.00	8-00	57856 000693
05	T-155-G	TERMINAL				B		0000	EA	6.00	12.00	9-00	55322 000694
05	N153P9006	SCR,PNH 4-40 X.375LG				B		0000	EA	2.00	4.00	10-00	000695
05	N400P35	WASHER,FLAT, NO. 4				*		0000	EA	2.00	4.00	11-00	000696
05	N415P11	WASHER, LOCK, #4				*		0000	EA	2.00	4.00	12-00	000697
05	47B381099PAR	WIRE,AWG 30,SLDRLESS				B		0000	FT		AR	13-00	000698
05	T-151-G	TERMINAL				B		0000	EA	21.00	42.00	14-00	55322 000699
05	SN60WRMAP2	SOLDER / QQ-S-571				B	5	0000	LB		AR	15-00	000700
05	47A380052	ELECTRICAL FAB. STD				X	5	0000	EA		X	16-00	000701
05	47D387038	SCHEMATIC				X		0000	EA		X	17-00	000702

LVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/	FSCM	CROSS
			INC	OUT		APPLY	C Y	TIME				REF DESG		REF
05	AWG-26-TYPE-S	BUS WIRE / QQ-W-343					B	0000	FT		AR		18-00	000703
05	CK06BX104K	CAPACITOR, .1 MFD					B 5	0000	EA	1.00		2.00 C1	-00	95275 000704
05	CK06BX104K	CAPACITOR, .1 MFD					B 5	0000	EA	1.00		2.00 C2	-00	95275 000705
05	150D106X9035R2	CAPACITOR, 10 MFD					B 5	0000	EA	1.00		2.00 C3	-00	56289 000706
05	CK06BX104K	CAPACITOR, .1 MFD					B 5	0000	EA	1.00		2.00 C4	-00	95275 000707
05	CK06BX104K	CAPACITOR, .1 MFD					B 5	0000	EA	1.00		2.00 C5	-00	95275 000708
05	RNC55H4530FS	RESISTOR, 453 OHMS					B	0000	EA	1.00		2.00 R1	-00	000709
05	RNC55H1102FS	RESISTOR, 11 K					B 5	0000	EA	1.00		2.00 R10	-00	000710
05	RNC55H1102FS	RESISTOR, 11 K					B 5	0000	EA	1.00		2.00 R11	-00	000711
05	3009P-1-202	POTENTIOMETER, 2 K					B	0000	EA	1.00		2.00 R12	-00	32997 000712
05	RNC55H9091FS	RESISTOR, 9.09 K					B 5	0000	EA	1.00		2.00 R13	-00	000713
05	RNC55H1001FS	RESISTOR					B 5	0000	EA	1.00		2.00 R14	-00	000714
05	3009P-1-202	POTENTIOMETER, 2 K					B	0000	EA	1.00		2.00 R15	-00	32997 000715
05	RNC55H1912FS	RESISTOR, 19.1 K					B 5	0000	EA	1.00		2.00 R16	-00	000716
05	3009P-1-501	POTENTIOMTR 500 OHMS					B	0000	EA	1.00		2.00 R17	-00	32997 000717
05	3009P-1-501	POTENTIOMTR 500 OHMS					B	0000	EA	1.00		2.00 R18	-00	32997 000718
05	3009P-1-501	POTENTIOMTR 500 OHMS					B	0000	EA	1.00		2.00 R19	-00	32997 000719
05	3009P-1-102	POTENTIOMETER, 1 K					B 7	0000	EA	1.00		2.00 R2	-00	32997 000720
05	3009P-1-501	POTENTIOMTR 500 OHMS					B	0000	EA	1.00		2.00 R20	-00	32997 000721
05	RNC55H1003FS	RESISTOR, 100 K					B 5	0000	EA	1.00		2.00 R3	-00	000722
05	RNC55H1271FS	RESISTOR, 1.27 K					B	0000	EA	1.00		2.00 R4	-00	000723
05	RNC55H1003FS	RESISTOR, 100 K					B 5	0000	EA	1.00		2.00 R5	-00	000724
05	RNC55H1003FS	RESISTOR, 100 K					B 5	0000	EA	1.00		2.00 R6	-00	000725
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00		2.00 R7	-00	000726
05	RNC55H1333FS	RESISTOR, 133 K					B	0000	EA	1.00		2.00 R8	-00	000727
05	RNC55H3922FS	RESISTOR, 39.2 K					B 5	0000	EA	1.00		2.00 R9	-00	000728
05	D55-4	SWITCH					B	0000	EA	1.00		2.00 S1	-00	95146 000729
05	SA810-C-96-0	SYN TO DC CONVERTER					M	0000	EA	1.00		2.00 U1	-00	14352 000730
05	TL087CP	OPERATIONAL AMPL					M	0000	EA	1.00		2.00 U2	-00	01295 000731
05	TL087CP	OPERATIONAL AMPL					M	0000	EA	1.00		2.00 U3	-00	01295 000732
05	TL087CP	OPERATIONAL AMPL					M	0000	EA	1.00		2.00 U4	-00	01295 000733
05	TL087CP	OPERATIONAL AMPL					M	0000	EA	1.00		2.00 U5	-00	01295 000734
05	2B20B	VOLT TO CUR CONV					M	0000	EA	1.00		2.00 U6	-00	24355 000735
05	2B20B	VOLT TO CUR CONV					M	0000	EA	1.00		2.00 U7	-00	24355 000736
05	TL087CP	OPERATIONAL AMPL					M	0000	EA	1.00		2.00 U8	-00	01295 000737
04	47D387087G1	ASSY, COLOR CODED FL*					*	0000	EA	7.00		7.00	23-00	000738
05	3502-1000	CONNECTOR					*	0000	EA	1.00		7.00	1-00	75037 000739
05	3417-7040	CONNECTOR					B 5	0000	EA	1.00		7.00	2-00	75037 000740
05	3302-37	CABLE 12" LG					*	0000	EA	1.00		7.00	3-00	75037 000741
04	3341-1L	JACK SOCKET KIT					*	0000	EA	7.00		7.00	24-00	52760 000742
04	47A381045P3	CLAMP,CABLE (.187 DI*					*	0000	EA	2.00		2.00	25-00	000743
04	47A381045P6	CLAMP,CABLE (.375 DI*					*	0000	EA	4.00		4.00	26-00	000744
04	3596A-3	TERMINAL BOARD					*	0000	EA	1.00		1.00	27-00	75382 000745
04	MS3596A-XP-3-38C	MARKER STRIP					*	0000	EA	1.00		1.00	28-00	75382 000746
04	9083	SPACER, THREADED					*	0000	EA	2.00		2.00	29-00	83330 000747
04	47B387082P1	SHIELD					*	0000	EA	1.00		1.00	30-00	000748

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LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC								
					PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT	APPLY	C Y	TIME					
04	24205	COMPOUND, (LOCKTITE)			*	0000	OZ		AR		31-00 05972	000749
04	5596A-8	TERMINAL BOARD			*	0000	EA		1.00	1.00	32-00 75382	000750
04	N153P15010	SCR, PH, #8-32			*	0000	EA		4.00	4.00	33-00	000751
04	N415P16	WASHER, LOCK, #8			*	0000	EA		30.00	30.00	34-00	000752
04	N678P15008	SCREW, FLAT HD			B 5	0000	EA		2.00	2.00	35-00	000753
04	N226P15	NUT, HEX, #8-32			B 5	0000	EA		6.00	6.00	36-00	000754
04	N153P16010	SCREW, PAN HD #10-32X*			*	0000	EA		4.00	4.00	37-00	000755
04	N415P19	WASHER, LOCK, #10			*	0000	EA		20.00	20.00	38-00	000756
04	N226P16	NUT, HEX, #10-32			*	0000	EA		16.00	16.00	39-00	000757
04	N153P15005	SCREW, PAN HD #8-32X5*			*	0000	EA		12.00	12.00	40-00	000758
04	N153P9003	SCREW, PAN HD #4-40X3*			*	0000	EA		4.00	4.00	41-00	000759
04	N415P11	WASHER, LOCK, #4			*	0000	EA		6.00	6.00	42-00	000760
04	N153P16007	SCREW, PAN HD			*	0000	EA		8.00	8.00	43-00	000761
04	N153P15005	SCREW, PAN HD #8-32X5*			*	0000	EA		4.00	4.00	44-00	000762
04	N153P13024	SCREW, PAN HD, #6-32			*	0000	EA		2.00	2.00	45-00	000763
04	N415P13	WASHER, LOCK, #6			*	0000	EA		6.00	6.00	46-00	000764
04	N400P37	WASHER, FL. #6			*	0000	EA		2.00	2.00	47-00	000765
04	N226P13	NUT, PLAIN HEX, #6-32			*	0000	EA		2.00	2.00	48-00	000766
04	N153P16005	SCREW, PAN HD #10-32X*			*	0000	EA		6.00	6.00	49-00	000767
04	N153P9012	SCREW, PAN HD #4-40X3*			*	0000	EA		2.00	2.00	50-00	000768
04	N226P9	NUT, HEX, #4-40			*	0000	EA		2.00	2.00	51-00	000769
04	47A387088	WIRE LIST			X	0000	EA		X		52-00	000770
04	L10BP12012	SCREW, PAN HD, M4X12			*	0000	EA		8.00	8.00	53-00	000771
04	SN60WRMAP2	SOLDER / QQ-S-571			B 5	0000	LB		AR		54-00	000772
04	47A381037P1	LACING TAPE			*	0000	FT		AR		55-00	000773
04	47A381043PAR	SLEEVEING, VINYL			*	0000	FT		AR		56-00	000774
04	44A0111-16-9	WIRE, AWG #16			B 5	0000	FT		AR		57-00 06090	000775
04	N400P39	WASHER, FLAT, #10			*	0000	EA		2.00	2.00	58-00	000776
04	47A380052	ELECTRICAL FAB. STD			X 5	0000	EA		X		59-00	000777
04	47E387061	SCHEMATIC			X	0000	EA		X		60-00	000778
04	N416P13	WSHR, LOCK, INTL T #6			*	0000	EA		1.00	1.00	61-00	000779
04	74755	PRIMER			*	0000	OZ		AR		62-00 05972	000780
04	MS5596-XP-8-8C	MARKER STRIP			*	0000	EA		1.00	1.00	63-00 75382	000781
04	47A380069P52	NAMEPLATE, IDENT (TB*)			*	0000	EA		1.00	1.00	64-00	000782
04	44A0111-22-9	WIRE, #22 AWG			B 5	0000	FT		AR		65-00 06090	000783
04	47A380071PAR	SLEEVEING, SHRINK			*	0000	FT		AR		66-00	000784
04	1488-6	SOLDER LUG			*	0000	EA		2.00	2.00	67-00 83330	000785
04	18RA-6	TERMINAL, LUG			*	0000	EA		8.00	8.00	68-00 59730	000786
04	18RA-6FLX	TERMINAL LUG, CRIMP			B 5	0000	EA		8.00	8.00	69-00 56501	000787
04	18RA-10	TERMINAL LUG, RING (*)			*	0000	EA		4.00	4.00	70-00 56501	000788
04	30B-010	WIRE WRAP WIRE (1")			*	0000	FT		AR		71-00 8666	000789
04	30W-020	WIRE WRAP WIRE (2")			*	0000	FT		AR		72-00 8666	000790
04	30Y-030	WIRE WRAP WIRE (3")			*	0000	FT		AR		73-00 8666	000791
04	30R-040	WIRE WRAP WIRE (4")			*	0000	FT		AR		74-00 8666	000792
04	30BLK-050	WIRE WRAP WIRE (5")			*	0000	FT		AR		75-00 8666	000793
04	30B-060	WIRE WRAP WIRE (6")			*	0000	FT		AR		76-00 8666	000794
04	30W-070	WIRE WRAP WIRE (7")			*	0000	FT		AR		77-00 8666	000795
04	30Y-080	WIRE WRAP WIRE (8")			*	0000	FT		AR		78-00 8666	000796
04	30R-090	WIRE WRAP WIRE (9")			*	0000	FT		AR		79-00 8666	000797

LVL IDENTIFICATION NO.		NOMENCLATURE		ECN		DWG		PL-LATE		P T CYCLE		U/M		PL-QTY		EXT/TOT QTY		ITEM/		FSCM CROSS	
				INC OUT		APPLY		C Y		TIME								REF DESG		REF	
04	30BLK-100	WIRE WRAP WIRE, (10")						*		0000	FT			AR				80-00	8666	000798	
04	WB-16	WIRE WRAP WIRE, ROLL						*		0000	FT			AR				81-00	8666	000799	
03	47E387093G1	WIND TRANSLATOR						M		0000	EA			1.00		1.00		34-00		000800	
03	**47E387062-35	SPCR, CABLE RETAINER						M		0000	EA			1.00		1.00		35-00		000801	
03	**47E387062-36	WIRE DUCT						M		0000	EA			2.00		2.00		36-00		000802	
03	**47E387062-37	WIRE DUCT COVER						M		0000	EA			2.00		2.00		37-00		000803	
03	722140	TERMINAL STRIP						M		0000	EA			8.00		8.00		38-00	52458	000804	
03	**47E387062-39	MARKER STRIP						M		0000	EA			8.00		8.00		39-00		000805	
03	**47E387062-40	CABLE ASSY, W1						M		0000	EA			1.00		1.00		40-00		000806	
03	**47E387062-41	CABLE ASSY, W2						M		0000	EA			1.00		1.00		41-00		000807	
03	**47E387062-42	CABLE ASSY, W3						M		0000	EA			1.00		1.00		42-00		000808	
03	**47E387062-43	CABLE ASSY, W4						M		0000	EA			1.00		1.00		43-00		000809	
03	**47E387062-44	CABLE ASSY, W5						M		0000	EA			1.00		1.00		44-00		000810	
03	**47E387062-45	CABLE ASSY, W6						M		0000	EA			1.00		1.00		45-00		000811	
03	**47E387062-46	CABLE ASSY, W7						M		0000	EA			1.00		1.00		46-00		000812	
03	**47E387062-47	CABLE ASSY, W8						M		0000	EA			1.00		1.00		47-00		000813	
03	**47E387062-48	CABLE ASSY, W9						M		0000	EA			1.00		1.00		48-00		000814	
03	**47E387062-49	CABLE ASSY, W10						M		0000	EA			1.00		1.00		49-00		000815	
03	47E387065G1	PANEL, RIGHT SIDE						*		0000	EA			1.00		1.00		50-00		000816	
04	47E387065P1	PANEL, RIGHT SIDE						*		0000	EA			1.00		1.00		1-00		000817	
04	S-0420-2-ZI	SELF CLINCHING FASTE*						*		0000	EA			12.00		12.00		2-00	46384	000818	
04	SS-024-3-ZI	SELF CLINCHING FASTE*						*		0000	EA			45.00		45.00		3-00	46384	000819	
04	S-832-3-ZI	SELF CLINCHING FASTE*						*		0000	EA			2.00		2.00		4-00	46384	000820	
04	S-632-3-ZI	SELF CLINCHING FASTE*						B 5		0000	EA			6.00		6.00		5-00	46384	000821	
03	**47E387062-51	WIRE DUCT						M		0000	EA			1.00		1.00		51-00		000822	
03	**47E387062-52	WIRE DUCT COVER						M		0000	EA			1.00		1.00		52-00		000823	
03	47C387096G1	MTG BRACKET ASSY						M		0000	EA			2.00		2.00		53-00		000824	
04	47C387096P1	MTG BRACKET						M		0000	EA			1.00		2.00		1-00		000825	
04	CLS-632-3	SELF CLINCHING FSTNR						B		0000	EA			8.00		16.00		2-00	46384	000826	
04	47A380102	FINISH						X		0000	PT					X		3-00		000827	
03	**47E387062-54	BLANK PANEL						M		0000	EA			1.00		1.00		54-00		000828	
03	N30AP16010	SCR, HEX HD, #10-32						B		0000	EA			151.00		151.00		55-00		000829	
03	N415P19	WASHER, LOCK, #10						*		0000	EA			187.00		187.00		56-00		000830	
03	N226P16	NUT, HEX, #10-32						*		0000	EA			103.00		103.00		57-00		000831	
03	N30AP21010	SCR, HEX HD, #1/4-20						B		0000	EA			37.00		37.00		58-00		000832	
03	N415P25	WASHER, LOCK, (1/4)						B		0000	EA			37.00		37.00		59-00		000833	
03	N400P39	WASHER, FLAT, #10						*		0000	EA			60.00		60.00		60-00		000834	
03	SFSW10F16CP-GO2NA	SCR, PANEL, #10-32						B		0000	EA			12.00		12.00		61-00	12324	000835	
03	SFSW10F8CP-GO2NA	SCR, PANEL, #10-32						B 5		0000	EA			12.00		12.00		62-00	12324	000836	
03	N678P15016	SCR, FLAT HD, #8-32						B		0000	EA			9.00		9.00		63-00		000837	
03	N415P16	WASHER, LOCK, #8						*		0000	EA			19.00		19.00		64-00		000838	
03	N226P15	NUT, HEX, #8-32						B 5		0000	EA			9.00		9.00		65-00		000839	
03	N153P9014	SCR, PH, #4-40						B		0000	EA			32.00		32.00		66-00		000840	
03	N415P11	WASHER, LOCK, #4						*		0000	EA			32.00		32.00		67-00		000841	

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I	VL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
				DWG INC	OUT									
03		N226P9	NUT, HEX, #4-40			*	0000	EA			32.00	32.00	68-00	000842
03		N334P1502	RIVET,DOMED HD,BLIND			B	0000	EA			50.00	50.00	69-00	000843
03		N30AP16007	SCR, HEX HD, #10-32			B	0000	EA			30.00	30.00	70-00	000844
03		A-PS1420CM	CLAMPING NUT			B	0000	EA			9.00	9.00	71-00	000845
03		N153P16006	SCR, PH, #10-32			*	0000	EA			18.00	18.00	72-00	000846
03		N153P15010	SCR, PH, #8-32			*	0000	EA			6.00	6.00	73-00	000847
03		N153P13016	SCR, PH, #6-32			B	0000	EA			13.00	13.00	74-00	000848
03		N415P13	WASHER, LOCK, #6			*	0000	EA			29.00	29.00	75-00	000849
03		N153P15006	SCR, PH, #8-32			*	0000	EA			4.00	4.00	76-00	000850
03		N153P13004	SCR, PH, #6-32			*	0000	EA			16.00	16.00	77-00	000851
03		SN60WRMAP2	SOLDER / QQ-S-571			B	5	0000	LB		AR		78-00	000852
03		47A381037P1	LACING TAPE			*	0000	FT			AR		79-00	000853
03		**47E387062-80	BRKT,PWR SUPPLY SPRT			M	0000	EA			8.00	8.00	80-00	000854
03		7022AD	RELAY			B	0000	EA			1.00	1.00	81-00	000855
03		47D387121G1	ESD ELECT ASSY			M	0000	EA			1.00	1.00	82-00	000856
04		47D387063P1	PANEL			M	0000	EA			1.00	1.00	1-00	000857
04		47D387063P2	MOUNTING CHASIS			M	0000	EA			1.00	1.00	2-00	000858
04		KHU17A11-120	RELAY			B	5	0000	EA		6.00	6.00	3-00	000859
04		KHU17D11-28	RELAY			B	0000	EA			1.00	1.00	4-00	000860
04		47-61-201-10	CAPTIVE SCREW			M	0000	EA			4.00	4.00	5-00	000861
04		N678P13007	SCR,FLH 6-32 X .44LG			M	0000	EA			4.00	4.00	6-00	000862
04		N415P13	WASHER, LOCK, #6			*	0000	EA			6.00	6.00	7-00	000863
04		N226P13	NUT,PLAIN HEX, #6-32			*	0000	EA			4.00	4.00	8-00	000864
04		N226P7	NUT, HEX 3-48			M	0000	EA			7.00	7.00	9-00	000865
04		N415P9	WASHER,LOCK, EXT T #3			M	0000	EA			7.00	7.00	10-00	000866
04		IN4005	DIODE			B	0000	EA			1.00	1.00	11-00	000867
04		47A381044PAR	SLEEVING,TEFLON			*	0000	FT			AR		12-00	000868
04		47A387125	WIRE LIST			X	0000	EA			X		13-00	000869
04		MRA20PJ	CONNECTOR			M	0000	EA			1.00	1.00	14-00	000870
04		6STV-15	TERMINAL STRIP			M	0000	EA			1.00	1.00	15-00	000871
04		TC6-15	COVER, TERM STRIP			M	0000	EA			1.00	1.00	16-00	000872
04		N195P1306	SCR,PNH 6-20 X .375LG			M	0000	EA			2.00	2.00	17-00	000873
04		44A0111-20-9	WIRE, AWG #20			B	5	0000	FT		AR		18-00	000874
04		AWG-20-TYPE-S	WIRE, BUS/QQ-W-343			B	0000	FT			AR		19-00	000875
04		47D387022	SCHEMATIC			X	0000	EA			X		20-00	000876
04		47A380052	ELECTRICAL FAB. STD			X	5	0000	EA		X		21-00	000877
04		47A380102P1	FINISH			M	0000	QT			AR		22-00	000878
04		SN60WRMAP2	SOLDER / QQ-S-571			B	5	0000	LB		AR		23-00	000879
04		47A381037P1	LACING TAPE			*	0000	FT			AR		24-00	000880
04		47A380071PAR	SLEEVING, SHRINK			*	0000	FT			AR		25-00	000881
03		47D387130G1	"G" SWITCH TEST ELEK			M	0000	EA			1.00	1.00	83-00	000882
04		47D387129P1	PANEL			M	0000	EA			1.00	1.00	1-00	000883
04		47D387129P2	MOUNTING CHASSIS			M	0000	EA			1.00	1.00	2-00	000884
04		47-61-201-10	CAPTIVE SCREW			M	0000	EA			4.00	4.00	3-00	000885
04		4156-14-1	TERMINAL			M	0000	EA			8.00	8.00	4-00	000886
04		KHU17A17-120	RELAY			M	0000	EA			6.00	6.00	5-00	000887

LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC OUT								
					APPLY	C Y	TIME					
04	MJ1000	TRANSISTOR				B 5	0000	EA	1.00	1.00	6-00 04713	000888
04	177-3-62	INSULATOR				B 5	0000	EA	1.00	1.00	7-00 05820	000889
04	MD-3452-G	SOCKET, TO-3				B 5	0000	EA	1.00	1.00	8-00 06770	000890
04	120-2	GREASE, THERMAL				B 5	0000	OZ	AR		9-00 05820	000891
04	LM10CH	OPERATIONAL AMPLIFIER				B 7	0000	EA	1.00	1.00	10-00 27014	000892
04	6140-188-1	SOCKET, 8 PIN				M	0000	EA	1.00	1.00	11-00 17117	000893
04	3059J-1-102M	POTENTIOMETER				M	0000	EA	2.00	2.00	12-00 32997	000894
04	WBR1000-50	CAPACITOR				B 5	0000	EA	1.00	1.00	13-00 14655	000895
04	150D105X9035A2	CAPACITOR				B 5	0000	EA	1.00	1.00	14-00 56289	000896
04	41F2R0	RESISTOR, 2 OHM				M	0000	EA	1.00	1.00	15-00 03615	000897
04	RN65C1004F	RESISTOR, 1M OHM				B 5	0000	EA	1.00	1.00	16-00	000898
04	MRA20PJ	CONNECTOR				M	0000	EA	1.00	1.00	17-00 79376	000899
04	6STV-10	TERMINAL STRIP				M	0000	EA	1.00	1.00	18-00 53337	000900
04	TC6-10	COVER, TERM. STRIP				M	0000	EA	1.00	1.00	19-00 53337	000901
04	47A387128	WIRE LIST				X	0000	EA	X		20-00	000902
04	47D387122	SCHEMATIC				X	0000	EA	X		21-00	000903
04	N678P13007	SCR, FLH 6-32 X .44LG				M	0000	EA	4.00	4.00	22-00	000904
04	N415P13	WASHER, LOCK, #6				*	0000	EA	8.00	8.00	23-00	000905
04	N226P13	NUT, PLAIN HEX, #6-32				*	0000	EA	4.00	4.00	24-00	000906
04	N226P7	NUT, HEX 3-48				M	0000	EA	6.00	6.00	25-00	000907
04	N415P9	WASHER, LOCK, EXT T #3				M	0000	EA	6.00	6.00	26-00	000908
04	N195P1306	SCR, PNH 6-20 X .375LG				M	0000	EA	2.00	2.00	27-00	000909
04	N153P13010	SCREW, PAN HD. #6-32				M	0000	EA	2.00	2.00	28-00	000910
04	N678P9008	SCREW, FLAT HD. #4-40				M	0000	EA	1.00	1.00	29-00	000911
04	N415P11	WASHER, LOCK, #4				*	0000	EA	1.00	1.00	30-00	000912
04	N226P9	NUT, HEX, #4-40				*	0000	EA	1.00	1.00	31-00	000913
04	47A380052	ELECTRICAL FAB. STD				X 5	0000	EA	X		32-00	000914
04	44A0111-20-9	WIRE, AWG #20				B 5	0000	FT	AR		33-00 06090	000915
04	AWG-20-TYPE-S	WIRE, BUS/QQ-W-343				B	0000	FT	AR		34-00	000916
04	47A380102P1	FINISH				M	0000	QT	AR		35-00	000917
04	SN60WRMAP2	SOLDER / QQ-S-571				B 5	0000	LB	AR		36-00	000918
04	47A381037P1	LACING TAPE				*	0000	FT	AR		37-00	000919
04	47A380071PAR	SLEEVING, SHRINK				*	0000	FT	AR		38-00	000920
04	47A381044PAR	SLEEVING, TEFLON				*	0000	FT	AR		39-00	000921
03	47D387132G1	ICE DETECTOR ELEK				M	0000	EA	1.00	1.00	84-00	000922
03	MRA20SJH1	CONNECTOR				B	0000	EA	3.00	3.00	85-00 79376	000923
03	**47E387062-86	WIRE DUCT				M	0000	EA	4.00	4.00	86-00	000924
03	**47E387062-87	WIRE DUCT COVER				M	0000	EA	4.00	4.00	87-00	000925
03	**47E387062-88	CIRCUIT BKR PANEL				M	0000	EA	1.00	1.00	88-00	000926
03	112-220-101	CIRCUIT BKR (20A)				B	0000	EA	2.00	2.00	89-00 77342	000927
03	112-215-101	CIRCUIT BKR (15A)				B	0000	EA	7.00	7.00	90-00 77342	000928
03	112-210-101	CIRCUIT BKR (10A)				*	0000	EA	7.00	7.00	91-00 77342	000929
03	112-205-101	CIRCUIT BKR (5A)				B	0000	EA	2.00	2.00	92-00 77342	000930
03	1422552	POWER BLOCK (2 CKT)				M	0000	EA	1.00	1.00	93-00 26405	000931
03	1423552	POWER BLOCK (3 CKT)				M	0000	EA	1.00	1.00	94-00 26405	000932
03	**47E387062-95	SAFETY SHIELD				M	0000	EA	1.00	1.00	95-00	000933
03	4697-1032-SS-20	HEX M & F STANDOFF				M	0000	EA	12.00	12.00	96-00 55566	000934
03	24205	COMPOUND, (LOKITE)				*	0000	OZ	AR		97-00 05972	000935

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LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE P T CYCLE U/M PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG INC	OUT				
03	74755	PRIMER			* 0000 OZ	AR	98-00	05972 000936
03	**47E387062-99	SPACER			M 0000 EA	13.00	99-00	000937
03	**47E387062-100	SUPPORT, (04-04-42-B)			M 0000 EA	13.00	100-00	000938
03	**47E387062-101	BUS BAR			M 0000 EA	1.00	101-00	000939
03	**47E387062-102	BUS BAR			M 0000 EA	1.00	102-00	000940
03	**47E387062-103	BUS BAR			M 0000 EA	1.00	103-00	000941
03	**47E387062-104	BUS BAR			M 0000 EA	1.00	104-00	000942
03	**47E387062-105	CONNECTION			M 0000 EA	130.00	105-00	000943
03	**47E387062-106	CONNECTION			M 0000 EA	62.00	106-00	000944
03	**47E387062-107	CONNECTION			M 0000 EA	4.00	107-00	000945
03	**47E387062-108	CONNECTION			M 0000 EA	1.00	108-00	000946
03	**47E387062-109	MARKERS (1 THRU 120)			M 0000 EA	1.00	109-00	000947
03	**47E387062-110	MARKERS (1 THRU 14)			M 0000 EA	1.00	110-00	000948
03	**47E387062-111	MARKERS (1 THRU 63)			M 0000 EA	1.00	111-00	000949
03	FD15-50	PWR SUPPLY, +/- 15VDC			M 0000 EA	1.00	112-00	14749 000950
03	B24N75	PWR SUPPLY, (24 VDC)			M 0000 EA	1.00	113-00	14749 000951
03	B28N70	PWR SUPPLY, (28 VDC)			M 0000 EA	1.00	114-00	14749 000952
03	B35FT40	PWR SUPPLY, (35 VDC)			M 0000 EA	1.00	115-00	14749 000953
03	47A380071PAR	SLEEVING, SHRINK			* 0000 FT	AR	116-00	000954
03	47A381043PAR	SLEEVING, VINYL			* 0000 FT	AR	117-00	000955
03	44A0811-12-9	WIRE, AWG #12			B 5 0000 FT	AR	118-00	06090 000956
03	44A0111-16-9	WIRE, AWG #16			B 5 0000 FT	AR	119-00	06090 000957
03	44A0111-20-9	WIRE, AWG #20			B 5 0000 FT	AR	120-00	06090 000958
03	18RA-6FLX	TERMINAL LUG, CRIMP			B 5 0000 EA	AR	121-00	56501 000959
03	10RC-10FLX	TERMINAL LUG, CRIMP			B 0000 EA	AR	122-00	56501 000960
03	**47E387062-123	BRKT, WIRING SUPPORT			M 0000 EA	1.00	123-00	000961
02	47E387060G1	HIGH VOLTAGE CG ASSY			M 0000 EA	1.00	17-00	000962
03	47E387069G1	HIGH V CG DRILL ASSY			M 0000 EA	1.00	1-00	000963
03	47D387009P1	GROUNDING XFMR			M 0000 EA	1.00	2-00	000964
03	47C387013P1	GROUNDING RESISTOR			M 0000 EA	2.00	3-00	000965
03	47D387010P1	CURRENT XFMR			M 0000 EA	6.00	4-00	000966
03	47D387011P1	POTENTIAL XFMR			M 0000 EA	3.00	5-00	000967
03	N24P25016	BOLT, HEX HEAD			B 0000 EA	12.00	6-00	000968
03	47D387110P1	BUS BAR			M 0000 EA	1.00	7-00	000969
03	N673P35	EYE BOLT			B 0000 EA	2.00	8-00	000970
03	47D387109G1	FRONT PANEL			M 0000 EA	1.00	9-00	000971
03	N227P25	NUT, HEX			B 0000 EA	12.00	10-00	000972
03	N415P75	WASHER, LOCK			B 0000 EA	2.00	11-00	000973
03	N227P35	NUT, HEX			B 0000 EA	2.00	12-00	000974
03	N415P37	WASHER, LOCK			B 0000 EA	36.00	13-00	000975
03	N24P25008	BOLT, HEX HD			B 0000 EA	24.00	14-00	000976
03	N24P29020	BOLT, HEX HD			B 0000 EA	36.00	15-00	000977
03	N415P50	WASHER, LOCK			B 0000 EA	36.00	16-00	000978
03	N227P29	NUT, HEX			B 0000 EA	36.00	17-00	000979
03	N27P21022	BOLT, HEX HD, SLOTTED			B 0000 EA	10.00	18-00	000980
03	N415P25	WASHER, LOCK, (1/4)			B 0000 EA	10.00	19-00	000981
03	N400P41	WASHER, FLAT			B 5 0000 EA	10.00	20-00	000982

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE APPLY	P C Y	T Y TIME	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG INC	OUT								
01	47E382590G1	ROTOR BLADE ASSY				M	0000	EA	1.00	1.00	4-00	000983
02	47J382287P1	CENTER BLADE SECT				M	0000	EA	1.00	1.00	1-00	000984
02	47E381105G1	BOLSTER ASSY				M	0000	EA	1.00	1.00	2-00	000985
03	47E382301P1	BOLSTER				M	0000	EA	2.00	2.00	1-00	000986
03	47D382550G1	SFT,TEETER BRG ASSY				M	0000	EA	1.00	1.00	2-00	000987
04	47D382550P1	CLOTH,FIBERGLASS				M	0000	FT	AR		1-00	000988
04	47D382550P2	ADHESIVE				M	0000	OZ	AR		2-00	000989
04	47D382397G1	TEETER PVT SFT ASSY				M	0000	EA	1.00	1.00	3-00	000990
05	47D382397P1	TEETER PIVOT SHAFT				M	0000	EA	1.00	1.00	1-00	000991
05	47C382390P1	PLUG, SHAFT TEETER				M	0000	EA	2.00	2.00	2-00	000992
03	47C382551G1	TEETER RESTR ASSY				M	0000	EA	4.00	4.00	3-00	000993
04	47C382551P1	CLOTH, FIBERGLASS				M	0000	FT	AR		1-00	000994
04	47C382551P2	ADHESIVE, EPOXY				M	0000	OZ	AR		2-00	000995
04	47C382351P1	TEETER SPRT INNER				M	0000	EA	1.00	4.00	3-00	000996
03	47C382551G2	TEETER RESTR ASSY				M	0000	EA	4.00	4.00	4-00	000997
04	47C382551P1	CLOTH, FIBERGLASS				M	0000	FT	AR		1-00	000998
04	47C382551P2	ADHESIVE, EPOXY				M	0000	OZ	AR		2-00	000999
04	47C382350P1	TEETER SPRT OUTER				M	0000	EA	1.00	4.00	4-00	001000
03	47C382552G1	BOLSTER INSR ASSY				M	0000	EA	2.00	2.00	5-00	001001
04	47C382552P1	CLOTH,FIBERGLASS				M	0000	FT	AR		1-00	001002
04	47C382552P2	ADHESIVE				M	0000	OZ	AR		2-00	001003
04	47E382403P1	INSERT,BOLSTER				M	0000	EA	1.00	2.00	3-00	001004
03	**47E381105-6	EPOXY,THICKENED				B	0000	EA	AR		6-00	001005
02	47J381090P1	INNER BLADE SECTION				M	0000	EA	2.00	2.00	3-00	001006
02	47J381097P1	OUTER BLADE SECTION				M	0000	EA	2.00	2.00	4-00	001007
02	47E381089P1	TRAILING EDGE INSTL				M	0000	EA	2.00	2.00	5-00	001008
02	47E381089P2	TRAILING EDGE INSTL				M	0000	EA	2.00	2.00	6-00	001009
02	47E381089P3	TRAILING EDGE INSTL				M	0000	EA	2.00	2.00	7-00	001010
02	47E382610G1	AILERON INSTALLATION				M	0000	EA	2.00	2.00	8-00	001011
03	**47E382610-1	AIL SECT,INDB DRIVE				M	0000	EA	2.00	4.00	1-00	001012
03	**47E382610-2	AIL SECT,INBD TRAIL				M	0000	EA	2.00	4.00	2-00	001013
03	**47E382610-3	AIL SECT,CENTER DR				M	0000	EA	2.00	4.00	3-00	001014
03	**47E382610-4	AIL SECT,CENTER TR				M	0000	EA	2.00	4.00	4-00	001015
03	**47E382610-5	AIL SECT,OUTBD DRIVE				M	0000	EA	2.00	4.00	5-00	001016
03	**47E382610-6	AIL SECT,OUTBD TRAIL				M	0000	EA	2.00	4.00	6-00	001017

ORIGINAL PARTS
OF POOR QUALITY

----- ECN -----												
LVL	IDENTIFICATION NO.	NOMENCLATURE	DWG		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT								
03	**47E382610-7	HINGE FITTING,INBD				M	0000	EA	2.00	4.00	7-00	001018
03	**47E382610-8	HINGE FITTING,INBD				M	0000	EA	2.00	4.00	8-00	001019
03	**47E382610-9	HINGE FITTING,CENTER				M	0000	EA	2.00	4.00	9-00	001020
03	**47E382610-10	HINGE FITTING,CENTER				M	0000	EA	2.00	4.00	10-00	001021
03	**47E382610-11	HINGE FITTING,OUTBD				M	0000	EA	2.00	4.00	11-00	001022
03	**47E382610-12	HINGE FITTING,OUTBD				M	0000	EA	2.00	4.00	12-00	001023
03	**47E382610-13	HINGE FITTING,TIP				M	0000	EA	2.00	4.00	13-00	001024
03	47C381115P1	ACTUATOR				B	0000	EA	6.00	12.00	14-00	001025
03	MXJRR-10AS	ROD END,MALE				B	0000	EA	6.00	12.00	15-00	73143 001026
03	FXJRR-10AS	ROD END,FEMALE				M	0000	EA	6.00	12.00	16-00	73143 001027
03	47C381087P1	NUT				M	0000	EA	28.00	56.00	17-00	001028
03	47C381088P1	WASHER,1.00 DIA				M	0000	EA	28.00	56.00	18-00	001029
03	**47E382610-19	PIN,SPECIAL				M	0000	EA	6.00	12.00	19-00	001030
03	N900P62C	RING,RETAINING				B	0000	EA	12.00	24.00	20-00	001031
03	N402P17C	WASHER,SHIM				B	0000	EA	6.00	12.00	21-00	001032
03	**47E382610-22	STUD,SPECIAL				M	0000	EA	6.00	12.00	22-00	001033
03	**47E382610-23	PIN,HOLLOW SPECIAL				M	0000	EA	6.00	12.00	23-00	001034
03	**47E382610-24	SPACER SLEEVE				M	0000	EA	12.00	24.00	24-00	001035
03	**47E382610-25	SPACER SLEEVE				M	0000	EA	6.00	12.00	25-00	001036
03	**47E382610-26	WASHER,SHIM				M	0000	EA	18.00	36.00	26-00	001037
03	**47E382610-27	WASHER,SPECIAL				M	0000	EA	24.00	48.00	27-00	001038
03	N271P35	NUT				B	0000	EA	24.00	48.00	28-00	001039
03	**47E382610-29	SHOULDER PIN				M	0000	EA	12.00	24.00	29-00	001040
03	**47E382610-30	SPACER SLEEVE				M	0000	EA	24.00	48.00	30-00	001041
03	**47E382610-31	PIN				M	0000	EA	6.00	12.00	31-00	001042
03	N900P75C	RING,RETAINING				B	0000	EA	12.00	24.00	32-00	001043
03	N402P18C	WASHER 3/4"DIA				B	5 0000	EA	12.00	24.00	33-00	001044
03	MODEL-RC	SHOCK ABSORBER				B	0000	EA	8.00	16.00	34-00	94389 001045
03	**47E382610-35	ACTUATOR ARM,ADJ				M	0000	EA	8.00	16.00	35-00	001046
03	N94P75024	SCREW,SHOULDER				B	0000	EA	8.00	16.00	36-00	001047
03	N264P33B	LOCKNUT				B	0000	EA	40.00	80.00	37-00	001048
03	N402P17B	WASHER				B	0000	EA	40.00	80.00	38-00	001049
03	N22P33036B	SCREW,HEX HD				B	0000	EA	32.00	64.00	39-00	001050
02	47E382582G1	BLADE TIP ATCH ASSY				M	0000	EA	2.00	2.00	9-00	001051
03	**47E382582-1	ATCH STRIP-NOSE SECT				M	0000	EA	2.00	4.00	1-00	001052
03	47E382334P1	TIP,BLADE				M	0000	EA	2.00	4.00	2-00	001053
03	D170-RF-6-6-5	INSERT,DELRIN				B	0000	EA	10.00	20.00	3-00	001054
03	N50P24020C	SCREW,HEX HD				B	0000	EA	10.00	20.00	4-00	001055
03	N400P43	WASHER,FLAT				B	0000	EA	10.00	20.00	5-00	001056
03	**47E382582-6	ATCH STRIP-UPPER FWD				M	0000	EA	2.00	4.00	6-00	001057
03	**47E382582-7	ATCH STRIP-UPPER AFT				M	0000	EA	2.00	4.00	7-00	001058
03	**47E382582-8	ATCH STRIP-LOWER FWD				M	0000	EA	2.00	4.00	8-00	001059
03	**47E382582-9	ATCH STRIP-LOWER AFT				M	0000	EA	2.00	4.00	9-00	001060
03	47E382582P10	ADHESIVE,EPOXY				B	0000	PT	AR		10-00	001061
03	47E382582P11	GLASSFIBER CLOTH				B	0000	FT	AR		11-00	001062
03	A15F7A1	SILICONE POTTING RTV				B	0000	PT	AR		12-00	001063
03	N197P2440	SCERW,WOOD,FLAT HD				B	0000	EA	AR		13-00	001064

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C	Y	TIME				
02	47E382469G1	ICE DETECTOR INSTL			M		0000	EA		2.00	2.00	10-00	001065
03	47C382464G1	RING & HOUSING ASSY			M		0000	EA		2.00	4.00	1-00	001066
04	47C382463G1	RING, MOUNTING			M		0000	EA		1.00	4.00	1-00	001067
05	47C382463P1	RING, MOUNTING			M		0000	EA		1.00	4.00	1-00	001068
05	TLC-4C-0500W	INSERT, COIL THREAD			B		0000	EA		5.00	20.00	2-00 26390	001069
04	ZTR-64D	CAN, HOUSING			M		0000	EA		1.00	4.00	2-00 19178	001070
03	47D381091P1	ICE DETECTOR			M		0000	EA		2.00	4.00	2-00	001071
03	47B382467P1	RETAINER			M		0000	EA		2.00	4.00	3-00	001072
03	47B382468P1	GASKET			M		0000	EA		2.00	4.00	4-00	001073
03	**47E382469-5	EPOXY, ASBESTOS			B		0000	QT		AR		5-00	001074
03	47B382467P2	RETAINER / COVER			M		0000	EA		2.00	4.00	6-00	001075
03	N678P21010	SCREW, 100 DEG CSK			B		0000	EA		10.00	20.00	7-00	001076
03	N678P9006	SCREW, 100 DEG CSK			B		0000	EA		10.00	20.00	8-00	001077
03	47B382470P1	GASKET, COVER			M		0000	EA		2.00	4.00	9-00	001078
02	47E382413G1	BALLAST INSTL			M		0000	EA		1.00	1.00	11-00	001079
03	47C382399P1	BLOCK, BALLAST			M		0000	EA		96.00	96.00	1-00	001080
03	47B382401P1	STUD			M		0000	EA		32.00	32.00	2-00	001081
03	47B382398P1	SPACER			M		0000	EA		AR		3-00	001082
03	N214DP44B	NUT			B		0000	EA		64.00	64.00	4-00	001083
03	**47E382413-5	WASHER			M		0000	EA		64.00	64.00	5-00	001084
03	**47E382413-6	HOUSING, BALLAST			M		0000	EA		2.00	2.00	6-00	001085
03	**47E382413-7	PLATE, RETAINER			M		0000	EA		2.00	2.00	7-00	001086
03	**47E382413-8	STEM, THREADED			M		0000	EA		2.00	2.00	8-00	001087
03	**47E382413-9	NUT			M		0000	EA		2.00	2.00	9-00	001088
03	**47E382413-10	WASHER			M		0000	EA		2.00	2.00	10-00	001089
03	**47E382413-11	SCREW, HEX HD			M		0000	EA		24.00	24.00	11-00	001090
03	**47E382413-12	PLATE, KEEPER			M		0000	EA		2.00	2.00	12-00	001091
03	**47E382413-13	SCREW, HEX HD			M		0000	EA		8.00	8.00	13-00	001092
03	**47E382413-14	INSERT			M		0000	EA		8.00	8.00	14-00	001093
03	**47E382413-15	INSERT			M		0000	EA		16.00	16.00	15-00	001094
02	47E382590P12	FIBERGLASS, CLOTH			B		0000	EA		AR		12-00	001095
02	47E382469G2	ICE DETECTOR INSTL			M		0000	EA		2.00	2.00	13-00	001096
03	47C382464G1	RING & HOUSING ASSY			M		0000	EA		2.00	4.00	1-00	001097
04	47C382463G1	RING, MOUNTING			M		0000	EA		1.00	4.00	1-00	001098
05	47C382463P1	RING, MOUNTING			M		0000	EA		1.00	4.00	1-00	001099
05	TLC-4C-0500W	INSERT, COIL THREAD			B		0000	EA		5.00	20.00	2-00 26390	001100
04	ZTR-64D	CAN, HOUSING			M		0000	EA		1.00	4.00	2-00 19178	001101

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C	Y					
03	**47E382469-5	EPOXY, ASBESTOS					B	0000	QT		AR	5-00	001102
03	47B382467P2	RETAINER / COVER					M	0000	EA	2.00	4.00	6-00	001103
03	N678P21010	SCREW, 100 DEG CSK					B	0000	EA	10.00	20.00	7-00	001104
03	47B382470P1	GASKET, COVER					M	0000	EA	2.00	4.00	9-00	001105
02	47E382400G1	LIGHTING PROT INSTL					M	0000	EA	2.00	2.00	14-00	001106
03	**47E382400-1	GROUND STRAP,BRAIDED					M	0000	EA	6.00	12.00	1-00	001107
03	N46P20B	SCREW,STEEL CAP					B	0000	EA	6.00	12.00	2-00	001108
03	47E382400P3	LIGHTING STRIP					M	0000	FT		AR	3-00	001109
03	47E382400P4	SPLICE PLATE					M	0000	EA	16.00	32.00	4-00	001110
03	**47E382400-5	EPOXT, WEST SYSTEM					B	0000	PT		AR	5-00	001111
03	47E382400P6	SHIM					M	0000	EA	2.00	4.00	6-00	001112
03	N197P816	SCREW,WOOD					B	0000	EA	32.00	64.00	7-00	001113
03	72-08116	EPOXY, CONDUCTIVE					B	0000	PT		AR	8-00	07700 001114
03	72-00005	CAULKING, CONDUCTIVE					B	0000	PT		AR	9-00	07700 001115
03	**47E382400-10	R.T.V, TEFLON					B	0000	PT		AR	10-00	001116
03	**47E382400-11	JOINT COMPOUND, ELEC					B	0000	PT		AR	11-00	09922 001117
03	47A380009	DES. REQMTS, ROTOR BL					X	0000	EA		X	12-00	001118
02	**47E382590-15	BUMPER INSTL					M	0000	EA	1.00	1.00	15-00	001119
02	**47E382590-16	TETHER RETENN INSTL					M	0000	EA	2.00	2.00	16-00	001120
02	**47E382590-17	ELEC INSTM INSTL					M	0000	EA	1.00	1.00	17-00	001121
02	47J382330G1	BLADE HYDRAULIC INST					M	0000	EA	1.00	1.00	18-00	001122
03	47J382330P1	TUBING HYDRAULIC					M	0000	FT	720.00	720.00	1-00	001123
03	47J382330P2	TUBING HYDRAULIC					M	0000	FT	480.00	480.00	2-00	001124
03	47C381066P2	HOSE ASSY					M	0000	EA	6.00	6.00	3-00	001125
03	47C381066P1	HOSE ASSY					M	0000	EA	4.00	4.00	4-00	001126
03	47E382357G1	BRACKET, INBOARD					M	0000	EA	2.00	2.00	5-00	001127
04	47E382357P1	BRACKET					M	0000	EA	1.00	2.00	1-00	001128
04	N926P225	INSERT, COIL THD					B	0000	EA	5.00	10.00	2-00	001129
03	47D382358P1	BRKT, OUTBOARD					M	0000	EA	2.00	2.00	6-00	001130
03	47C382336G1	BRKT, CLAMP MODIFIED					M	0000	EA	38.00	38.00	7-00	001131
04	47C382336P1	BRACKET, ANGLE					M	0000	EA	2.00	76.00	1-00	001132
04	47C381072P3	CLAMP UNIT					M	0000	EA	1.00	38.00	2-00	001133
03	47C382336G2	BRKT, CLAMP MODIFIED					M	0000	EA	8.00	8.00	8-00	001134
04	47C382336P1	BRACKET, ANGLE					M	0000	EA	2.00	16.00	1-00	001135
04	47C381072P3	CLAMP UNIT					M	0000	EA	1.00	8.00	2-00	001136
03	47C381072P2	CLAMP UNIT					M	0000	EA	52.00	52.00	9-00	001137
03	47C381072P1	CLAMP UNIT					M	0000	EA	4.00	4.00	10-00	001138
03	47C382335P2	TUBE ADAPTER					M	0000	EA	6.00	6.00	11-00	001139

I/VL	IDENTIFICATION NO.	NOMENCLATURE	INC	DWG	ECN	PL-LATE	P	T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/REF	FSCM	CROSS	REF
03	47C382335P1	TUBE ADAPTER					M	0000	EA			4.00			12-00		001140
03	C-MA-32	ADAPTER, MOUNTING					B	0000	EA			8.00			13-00	30780	001141
03	47B382338P1	STUD, MOUNTING					M	0000	EA			10.00			14-00		001142
03	C-SN-32	NUT, STACKING					B	5	0000	EA		332.00			15-00	30780	001143
03	C-TA-32	ADAPTER, THREADED					B	5	0000	EA		166.00			16-00	30780	001144
03	47C382337P1	ADAPTER, TUBE					M	0000	EA			12.00			17-00		001145
03	100-8-F8SS	ADAPTER, TUBE					B	0000	EA			8.00			18-00	97576	001146
03	900-14SS	UNION, BULKHEAD					B	0000	EA			6.00			19-00	97576	001147
03	900-8SS	UNION, BULKHEAD					B	0000	EA			4.00			20-00	97576	001148
03	47C382349P1	SLEEVE, SPLIT					M	0000	EA			150.00			21-00		001149
03	47C382349P2	SLEEVE, SPLIT					M	0000	EA			100.00			22-00		001150
03	C-SB-32-16	BUSHING, SPLIT					B	5	0000	EA		150.00			23-00	30780	001151
03	C-SB-32-14	BUSHING, SPLIT					B	5	0000	EA		6.00			24-00	30780	001152
03	C-SB-32-10	BUSHING, SPLIT					B	5	0000	EA		100.00			25-00	30780	001153
03	C-SB-32-8	BUSHING, SPLIT					B	5	0000	EA		4.00			26-00	30780	001154
03	47D382361G1	BASE, HOSE SUPPORT					M	0000	EA			2.00			27-00		001155
04	47D382361P1	PLATE					M	0000	EA			1.00			1-00		001156
04	47D382361P2	PAD					M	0000	EA			1.00			2-00		001157
04	N926P225	INSERT, COIL THD					B	0000	EA			4.00			3-00		001158
04	**47D382361-4	ADHESIVE					B	0000	PT			AR			4-00		001159
03	47C382360G1	SUPPORT, HOSE					M	0000	EA			2.00			28-00		001160
04	47C382360P1	PLATE					M	0000	EA			1.00			1-00		001161
04	47C382360P2	PAD					M	0000	EA			1.00			2-00		001162
04	N926P225	INSERT, COIL THD					B	0000	EA			2.00			3-00		001163
04	**47C382360-4	ADHESIVE					B	0000	PT			AR			4-00		001164
03	47C382359P1	PLATE					M	0000	EA			4.00			29-00		001165
03	47B382373P1	SPACER					M	0000	EA			8.00			30-00		001166
03	47B382373P2	SPACER					M	0000	EA			8.00			31-00		001167
03	47B382373P3	SPACER					M	0000	EA			8.00			32-00		001168
03	C-B-32	BOLT, .375-16 1.00 LG					B	5	0000	EA		322.00			33-00	30780	001169
03	C-N-32	NUT, .375-16					B	5	0000	EA		8.00			34-00	30780	001170
03	C-LW-32	LOCKWASHER					B	5	0000	EA		330.00			35-00	30780	001171
03	N72P29024B	BOLT, .500-13 1.50 LG					B	5	0000	EA		16.00			36-00		001172
03	N40SP45B	WASHER, LOCK					B	5	0000	EA		16.00			37-00		001173
03	N40SP43B	LOCKWASHER - MEDIUM					B	5	0000	EA		248.00			38-00		001174
03	N22P25012B	BOLT, .375-16 .75 LG					B	5	0000	EA		104.00			39-00		001175
03	N22P25020B	BOLT 3/8-16 X 1-1/4"					B	5	0000	EA		28.00			40-00		001176
03	N22P25038B	BOLT, .375-16 2.38 LG					B	5	0000	EA		4.00			41-00		001177
03	N22P25042B	BOLT, .375-16 2.88 LG					B	5	0000	EA		4.00			42-00		001178
03	N22P25074B	BOLT, .375-16 4.62 LG					B	5	0000	EA		4.00			43-00		001179
03	**47J382330-44	SLEEVING					M	0000	EA			4.00			44-00		001180
03	**47J382330-45	SLEEVING, SHRINK					M	0000	EA			8.00			45-00		001181
03	N22P25034B	BOLT, .375-16 2.12 LG					B	5	0000	EA		8.00			46-00		001182
03	**47J382330-47	BRAZING ALLOY					B	0000	EA			AR			47-00		001183
03	47C382336G3	BRKT, CLAMP					M	0000	EA			6.00			48-00		001184

LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE P T CYCLE U/M PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF	
			DWG INC	OUT APPLY					
04	47C382336P1	BRACKET,ANGLE			M 0000 EA	2.00	12.00	1-00	001185
04	47C381072P3	CLAMP UNIT			M 0000 EA	1.00	6.00	2-00	001186
02	47D382406	GEOMETRY DWG			X 0000 EA	X		19-00	001187
02	47E382460	BLADE TOLERANCE DWG			X 0000 EA	X		20-00	001188
02	**47E382590-21	CONNECTING PLATE			M 0000 EA	2.00	2.00	21-00	001189
02	**47E382590-22	CONNECTING PLATE			M 0000 EA	2.00	2.00	22-00	001190
02	47E382590P23	ADHESIVE,EPOXY			B 0000 PT	AR		23-00	001191
02	47E382605G1	TEETER BRG/RSTR INST			M 0000 EA	1.00	1.00	24-00	001192
03	47E382602P2	YOKE BRG CAP			M 0000 EA	2.00	2.00	1-00	001193
03	47E382583G1	TEETER HUB/BRG ASSY			M 0000 EA	2.00	2.00	2-00	001194
04	47D381114P1	BRG,RADIAL-TEETER			M 0000 EA	1.00	2.00	1-00	001195
04	47E382581P1	HUB, BRG - TEETER			M 0000 EA	1.00	2.00	2-00	001196
04	47E382583P3	DOWEL PIN			M 0000 EA	3.00	6.00	3-00	001197
03	47E381093P1	BGR THRUST TEETER			M 0000 EA	2.00	2.00	3-00	001198
03	47B382396P1	SHIM,BRG			M 0000 EA	2.00	2.00	4-00	001199
03	47D381101P1	SHRINK DISC			M 0000 EA	2.00	2.00	5-00	001200
03	N060	LOCKNUT,TYPE SD			B 0000 EA	2.00	2.00	6-00	80648 001201
03	P60	LOCK PLATE			B 0000 EA	2.00	2.00	7-00	80648 001202
03	V1120E	SEAL-VEE RING			B 0000 EA	2.00	2.00	8-00	001203
03	47D382352G1	TEETER ARM ASSY			M 0000 EA	4.00	4.00	9-00	001204
04	47D382352P1	TEETER ARM			M 0000 EA	1.00	4.00	1-00	001205
04	47D382352P2	RETAINING RING			M 0000 EA	1.00	4.00	2-00	001206
04	GE160TG3AS-2RS	MONO BEARING			B 0000 EA	1.00	4.00	3-00	52676 001207
04	N22BP21014B	BOLT,LOCK			B 0000 EA	8.00	32.00	4-00	001208
04	N402P11B	WASHER, NARROW			B 5 0000 EA	8.00	32.00	5-00	001209
03	47C382353P1	TEETER SUPPORT PIN			M 0000 EA	4.00	4.00	10-00	001210
03	N22BP82080B	BOLT,LOCK			B 0000 EA	36.00	36.00	11-00	001211
03	N402P20B	WASHER			B 0000 EA	36.00	36.00	12-00	001212
03	47E382488P1	PRE-LOAD FIXTURE			M 0000 EA	2.00	2.00	13-00	001213
03	**47E382605-14	PRE-LOAD COLLAR			M 0000 EA	2.00	2.00	14-00	001214
03	**47E382605-15	LOADING STUD			M 0000 EA	6.00	6.00	15-00	001215
03	**47E382605-16	HYDR EXTENDER			M 0000 EA	2.00	2.00	16-00	001216
03	N22BP29020B	BOLT, SLFLKG			B 0000 EA	24.00	24.00	17-00	001217
03	N402P15B	WASHER			B 0000 EA	24.00	24.00	18-00	001218
03	47E382605P19	PIN			M 0000 EA	4.00	4.00	19-00	001219
02	N197P2048	SCREW,WOOD			B 0000 EA	AR		25-00	001220
02	**47E382590-26	BUTT WEDGE-REAR SPAR			M 0000 EA	2.00	2.00	26-00	001221
02	**47E382590-27	JOINT WEDGE-UPPER			M 0000 EA	2.00	2.00	27-00	001222
02	**47E382590-28	JOINT WEDGE-LOWER			M 0000 EA	2.00	2.00	28-00	001223
02	47A380009	DES. REQMTS,ROTOR BL			X 0000 EA	X		29-00	001224
02	47D382406	GEOMETRY DWG			X 0000 EA	X		30-00	001225

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE APPLY	P C	T Y	CYCLE TIME	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG INC	OUT									
02	47E382460	BLADE TOLERANCE DWG				X		0000	EA		X	31-00	001226
02	47E382440	SCHEM ROTOR HYDR SYS				X		0000	EA		X	32-00	001227
02	47A382285	PROFILE COORDINATES				X		0000	EA		X	33-00	001228
01	47E382607G1	YOKE / NACELLE INSTL				M		0000	EA	1.00	1.00	5-00	001229
02	47E382597G1	NACELLE OVERALL ASSY	1			X		0000	EA		X	1-00	001230
02	47E382601G1	YOKE ASSY				X		0000	EA		X	2-00	001231
02	47E382599G1	SLIP RING INST				M		0000	EA	1.00	1.00	3-00	001232
03	**47E382599-1	SUPPORT TUBE				M		0000	EA	1.00	1.00	1-00	001233
03	**47E382599-2	SUPPORT PADS				M		0000	EA	2.00	2.00	2-00	001234
03	47E382486P1	SIDE SUPPORT				M		0000	EA	1.00	1.00	3-00	001235
03	47D381018	ELEC INTERFACE				X		0000	EA		X	4-00	001236
03	47D381020P1	ROTOR SLIPRING UNIT				M		0000	EA	1.00	1.00	5-00	001237
03	47C381111P1	BELLOWS JOINT				M		0000	EA	1.00	1.00	6-00	001238
03	**47E382599-7	CONDUIT TIE BLOCK				M		0000	EA	3.00	3.00	7-00	001239
03	**47E382599-8	CONDUIT SPACER PAD				M		0000	EA	6.00	6.00	8-00	001240
03	47E382599P9	CONDUIT 2.00 DIA				M		0000	EA	3.00	3.00	9-00	001241
03	47E382599P10	CONDUIT 1.50 DIA				M		0000	EA	6.00	6.00	10-00	001242
03	**47E382599-11	JUNCTION BOX				M		0000	EA	1.00	1.00	11-00	001243
03	**47E382599-12	SEALING COLLAR				M		0000	EA	1.00	1.00	12-00	001244
03	A15B36	ADHESIVE,EPOXY				B		0000	DZ		AR	13-00	001245
03	B12B33	ADHESIVE,AL TAPE				B		0000	FT		AR	14-00	001246
03	N22BP29016B	BOLT, LOCK				B		0000	EA	12.00	12.00	15-00	001247
03	N402P15B	WASHER				B		0000	EA	16.00	16.00	16-00	001248
03	N22P29032B	BOLT				B		0000	EA	4.00	4.00	17-00	001249
03	N264P29B	NUT 1/2				B	5	0000	EA	4.00	4.00	18-00	001250
03	47E382599P19	ANGLES				M		0000	EA	2.00	2.00	19-00	001251
03	47D381024P1	ROTARY POSITION SR				M		0000	EA	1.00	1.00	20-00	001252
02	47E382496G1	LOW SPEED BRAKE INST				M		0000	EA	1.00	1.00	4-00	001253
03	47E382495G1	LOW SP BK SPRT ASSY				M		0000	EA	2.00	2.00	1-00	001254
04	47E382407P1	LOW SP BK SPRT BRKT				M		0000	EA	1.00	2.00	1-00	001255
04	47D382461P1	LOW SPEED BRAKE				M		0000	EA	4.00	8.00	2-00	001256
04	47D382492P4	NUT PLATE				M		0000	EA	2.00	4.00	3-00	001257
04	47D382492P2	NUT PLATE				M		0000	EA	2.00	4.00	4-00	001258
04	47D382492P1	NUT PLATE				M		0000	EA	1.00	2.00	5-00	001259
04	47D382492P3	NUT PLATE				M		0000	EA	1.00	2.00	6-00	001260
04	47D382493P3	NUT PLATE				M		0000	EA	2.00	4.00	7-00	001261
04	47D382493P1	NUT PLATE				M		0000	EA	2.00	4.00	8-00	001262
04	47D382493P2	NUT PLATE				M		0000	EA	1.00	2.00	9-00	001263
04	47B382494P1	NUT PLATE				M		0000	EA	8.00	16.00	10-00	001264
04	N46P22032B	SCREW, FLAT HD				B		0000	EA	38.00	76.00	11-00	001265
04	N402AP20B	WASHER				B		0000	EA	24.00	48.00	12-00	001266
04	47C381036P5	BOLT,FATIGUE RATED				B		0000	EA	24.00	48.00	13-00	001267
03	47C381036P3	BOLT,FATIGUE RATED				B		0000	EA	84.00	84.00	2-00	001268

LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC								
					APPLY	C	Y	TIME				
03	47C381088P1	WASHER, 1.00 DIA				M	0000	EA	84.00	84.00	3-00	001269
03	47C381036P10	BOLT, FATIGUE RATED				B	0000	EA	8.00	8.00	4-00	001270
03	47C381088P5	WASHER, 1.25 DIA				B	0000	EA	8.00	8.00	5-00	001271
03	81341EB-30	EYE BOLT				B	0000	EA	2.00	2.00	6-00	001272
03	A15F6C18	RTV SILICONE SEALANT				M	0000	OZ	AR		7-00	001273
02	47E382498G1	RTR SPEED SNSR INSTL				M	0000	EA	1.00	1.00	5-00	001274
03	47B382480P1	BRACKET, SENSOR				M	0000	EA	2.00	2.00	1-00	001275
03	47B381108P1	SENSOR, ROTOR SPEED				M	0000	EA	2.00	2.00	2-00	81692 001276
03	N733P25016B	SCREW, TWELVE-POINT				B	0000	EA	4.00	4.00	3-00	001277
03	N405P43B	LOCKWASHER - MEDIUM				B	5 0000	EA	4.00	4.00	4-00	001278
02	47C381036P26	BOLT, FATIGUE RATED				B	0000	EA	96.00	96.00	6-00	001279
02	47C381087P9	NUT				B	0000	EA	96.00	96.00	7-00	001280
02	47C381088P9	WASHER, 1.50 DIA				M	0000	EA	96.00	96.00	8-00	001281
02	47C381088P10	WASHER, 1.50 DIA				B	0000	EA	96.00	96.00	9-00	001282
02	**47E382607-10	SEAL, STATOR HALVES				M	0000	EA	2.00	2.00	10-00	001283
02	**47E382607-11	SEAL PLATE				M	0000	EA	6.00	6.00	11-00	001284
02	**47E382607-12	SEAL				M	0000	EA	1.00	1.00	12-00	001285
02	**47E382607-13	LOCKBOLT				M	0000	EA	AR		13-00	001286
02	**47E382607-14	WASHER				M	0000	EA	AR		14-00	001287
02	A15F6C18	RTV SILICONE SEALANT				M	0000	OZ	AR		15-00	001288
01	47E382608G1	ROTOR BLADE INSTL				M	0000	EA	1.00	1.00	6-00	001289
02	47B382396P1	SHIM, BRG				X	0000	EA	X		1-00	001290
02	47C381036P10	BOLT, FATIGUE RATED				B	0000	EA	60.00	60.00	2-00	001291
02	47C381087P6	LOCKNUT				B	0000	EA	60.00	60.00	3-00	001292
02	47C381088P9	WASHER, 1.50 DIA				M	0000	EA	60.00	60.00	4-00	001293
02	47C381088P10	WASHER, 1.50 DIA				B	0000	EA	60.00	60.00	5-00	001294
02	47C381036P21	BOLT				B	0000	EA	8.00	8.00	6-00	001295
02	47C381087P10	LOCKNUT				B	0000	EA	8.00	8.00	7-00	001296
02	47C381088P9	WASHER, 1.50 DIA				M	0000	EA	8.00	8.00	8-00	001297
02	47C381088P10	WASHER, 1.50 DIA				B	0000	EA	8.00	8.00	9-00	001298
02	N22BP82080B	BOLT, LOCK				B	0000	EA	36.00	36.00	10-00	001299
02	N402P20B	WASHER				B	0000	EA	36.00	36.00	11-00	001300
02	**47E382608-12	TEETER POSN IND				M	0000	EA	1.00	1.00	12-00	001301
02	**47E382608-13	TEETER MOTION INSTL				M	0000	EA	1.00	1.00	13-00	001302
02	**47E382608-14	FLEX HOSE				M	0000	EA	2.00	2.00	14-00	001303
02	**47E382608-15	FLEX HOSE				M	0000	EA	2.00	2.00	15-00	001304
02	**47E382608-16	FLEX HOSE				M	0000	EA	2.00	2.00	16-00	001305
01	**47E382304-7	GND SPRT EQUIP INSTL				M	0000	EA	1.00	1.00	7-00	001306
01	47E382045	GEOMETRY ENVELOPE				X	0000	EA	X		8-00	001307
01	47E387081G1	ELEC EQUIP BUILDING				M	0000	EA	1.00	1.00	9-00	001308
02	**47E387081-1	GRND ENCLOSURE BLDG				M	0000	EA	1.00	1.00	1-00	001309
02	**47E387081-2	TRANSFORMER				M	0000	EA	1.00	1.00	2-00	001310

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C Y	TIME					
04	N226P13	NUT, PLAIN HEX, #6-32					*	0000	EA	2.00	2.00	30-00	001358
04	N226P15	NUT, HEX, #8-32					B 5	0000	EA	4.00	4.00	31-00	001359
04	N226P16	NUT, HEX, #10-32					*	0000	EA	6.00	6.00	32-00	001360
04	18RA-8FLX	TERMINAL LUG, CRIMP(2*					B 5	0000	EA	3.00	3.00	33-00 56501	001361
04	18RA-10FLX	TERMINAL LUG, CRIMP(2*					B 5	0000	EA	1.00	1.00	34-00 56501	001362
04	RB4	WIRE JOINT					*	0000	EA	1.00	1.00	35-00 56501	001363
04	44A0111-16-9	WIRE, AWG #16					B 5	0000	FT	AR		36-00 06090	001364
04	RC6	WIRE JOINT					*	0000	EA	1.00	1.00	37-00 56501	001365
04	47A380071PAR	SLEEVING, SHRINK					*	0000	FT	AR		38-00	001366
04	47A381038P3	TAPE, LACING					*	0000	FT	AR		39-00	001367
04	SN60WRMAP2	SOLDER / QQ-S-571					B 5	0000	LB	AR		40-00	001368
04	47D387030	SCHEMATIC DIAGRAM EL*					X 5	0000	EA	X		41-00	001369
04	47A380052	ELECTRICAL FAB. STD					X 5	0000	EA	X		42-00	001370
03	47E387091G1	ASSY, GENERATOR PANEL					M	0000	EA	1.00	1.00	3-00	001371
04	47E387105P1	PANEL, FRONT					B	0000	EA	1.00	1.00	1-00	001372
04	47E387091P2	PANEL, SIDE					B	0000	EA	1.00	1.00	2-00	001373
04	47D387106P1	PANEL, REAR					B	0000	EA	1.00	1.00	3-00	001374
04	FCA4	HANDLE					B 5	0000	EA	2.00	2.00	4-00 08730	001375
04	47D387107P1	SGL CD FR., MODIFIED					B	0000	EA	1.00	1.00	5-00	001376
04	47D387108P1	BRACKET, CARD FRAME					B	0000	EA	1.00	1.00	6-00	001377
04	DM-3100N	DIGITAL, METER					B 5	0000	EA	6.00	6.00	7-00 50521	001378
04	58-2073082	EDGE CONNECTOR					B 5	0000	EA	6.00	6.00	8-00 50521	001379
04	47D387089G1	ASSY, MTR SIG CONDTNR					M	0000	EA	3.00	3.00	9-00	001380
05	47E387116P1	DRILL & TRIM					M	0000	EA	1.00	3.00	1-00	001381
05	AWG-22-TYPE-S	BUS WIRE/ QQ-W-343					B 5	0000	FT	AR		2-00	001382
05	47A381044PAR	SLEEVING, TEFLON					*	0000	FT	AR		3-00	001383
05	IC-314-SGT	SOCKET, 14 PIN					B	0000	EA	2.00	6.00	4-00 55322	001384
05	IC-316-SGT	SOCKET, 16 PIN					B	0000	EA	4.00	12.00	5-00 55322	001385
05	SN60WRMAP2	SOLDER / QQ-S-571					B 5	0000	LB	AR		6-00	001386
05	47D387092	SCHEMATIC					X	0000	EA	X		7-00	001387
05	47A380052	ELECTRICAL FAB. STD					X 5	0000	EA	X		8-00	001388
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR1	-00 01295	001389
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR2	-00 01295	001390
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR3	-00 01295	001391
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR4	-00 01295	001392
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR5	-00 01295	001393
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR6	-00 01295	001394
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR7	-00 01295	001395
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR8	-00 01295	001396
05	1N4148	DIODE					B 7	0000	EA	1.00	3.00 CR9	-00 01295	001397
05	CKR05BX221KR	CAPACITOR, 200 PF					B	0000	EA	1.00	3.00 C1	-00	001398
05	199D106X0010BB1	CAPACITOR, 10 MFD					B	0000	EA	1.00	3.00 C2	-00 56289	001399
05	CKR06BX103KR	CAPACITOR, .01 MFD					B	0000	EA	1.00	3.00 C3	-00	001400
05	CKR06BX104KR	CAPACITOR, .1 MFD					B	0000	EA	1.00	3.00 C4	-00	001401
05	CKR06BX104KR	CAPACITOR, .1 MFD					B	0000	EA	1.00	3.00 C5	-00	001402
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	3.00 E1	-00 55322	001403

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM	CROSS REF
			DWG INC	OUT									
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E10	-00	55322 001404
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E11	-00	55322 001405
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E12	-00	55322 001406
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E13	-00	55322 001407
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E14	-00	55322 001408
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E15	-00	55322 001409
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E16	-00	55322 001410
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E17	-00	55322 001411
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E18	-00	55322 001412
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E19	-00	55322 001413
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E2	-00	55322 001414
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E3	-00	55322 001415
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E4	-00	55322 001416
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E5	-00	55322 001417
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E6	-00	55322 001418
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E7	-00	55322 001419
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E8	-00	55322 001420
05	T-1R2-T	TERMINAL			B	0000	EA		1.00	3.00	E9	-00	55322 001421
05	53451-1	RELAY			B	7 0000	EA		1.00	3.00	K1	-00	18342 001422
05	53451-1	RELAY			B	7 0000	EA		1.00	3.00	K2	-00	18342 001423
05	53451-1	RELAY			B	7 0000	EA		1.00	3.00	K3	-00	18342 001424
05	RCR05G102JS	RESISTOR, 1K			B	7 0000	EA		1.00	3.00	R1	-00	001425
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R10	-00	001426
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R11	-00	001427
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R12	-00	001428
05	RNC55H101FS	RESISTOR, 1.1K			B	5 0000	EA		1.00	3.00	R13	-00	001429
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R14	-00	001430
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R15	-00	001431
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R16	-00	001432
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R17	-00	001433
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R18	-00	001434
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R19	-00	001435
05	RCR05G102JS	RESISTOR, 1K			B	7 0000	EA		1.00	3.00	R2	-00	001436
05	64Y103	POTENTIOMETER, 10K			B	0000	EA		1.00	3.00	R20	-00	02111 001437
05	64Y102	POTENTIOMETER, 1K			B	0000	EA		1.00	3.00	R21	-00	02111 001438
05	64Y103	POTENTIOMETER, 10K			B	0000	EA		1.00	3.00	R22	-00	02111 001439
05	64Y102	POTENTIOMETER, 1K			B	0000	EA		1.00	3.00	R23	-00	02111 001440
05	64Y103	POTENTIOMETER, 10K			B	0000	EA		1.00	3.00	R24	-00	02111 001441
05	64Y102	POTENTIOMETER, 1K			B	0000	EA		1.00	3.00	R25	-00	02111 001442
05	RCR05G102JS	RESISTOR, 1K			B	7 0000	EA		1.00	3.00	R3	-00	001443
05	RCR05G102JS	RESISTOR, 1K			B	7 0000	EA		1.00	3.00	R4	-00	001444
05	RCR05G471JS	RESISTOR, 470			B	7 0000	EA		1.00	3.00	R5	-00	001445
05	RNC55H2490FS	RESISTOR, 249			B	0000	EA		1.00	3.00	R6	-00	001446
05	RNC55H2490FS	RESISTOR, 249			B	0000	EA		1.00	3.00	R7	-00	001447
05	RNC55H2490FS	RESISTOR, 249			B	0000	EA		1.00	3.00	R8	-00	001448
05	RNC55H1002FS	RESISTOR			B	5 0000	EA		1.00	3.00	R9	-00	001449
05	SN7475N	4-BIT BISTABLE LCH			B	5 0000	EA		1.00	3.00	U1	-00	01295 001450
05	UHP-407	DRIVER			B	7 0000	EA		1.00	3.00	U2	-00	56289 001451
05	TLO84CN	QUAD JFET OPNL AMPL			B	7 0000	EA		1.00	3.00	U3	-00	01295 001452

LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	INC								
			INC	OUT	APPLY	C	Y	TIME				
04	AML12CBC3AA	SWITCH, (MOM)				B	0000	EA	9.00	9.00	10-00	91929 001453
04	**47E387091-11	LENS, ENGRAVED				M	0000	EA	1.00	1.00	11-00	001454
04	**47E387091-12	LENS, ENGRAVED				B	0000	EA	1.00	1.00	12-00	001455
04	**47E387091-13	LENS, ENGRAVED				B	0000	EA	1.00	1.00	13-00	001456
04	**47E387091-14	LENS, ENGRAVED				B	0000	EA	2.00	2.00	14-00	001457
04	**47E387091-15	LENS, ENGRAVED				B	0000	EA	2.00	2.00	15-00	001458
04	**47E387091-16	LENS, ENGRAVED				B	0000	EA	2.00	2.00	16-00	001459
04	**47E387091-17	LENS, ENGRAVED				B	0000	EA	3.00	3.00	17-00	001460
04	**47E387091-18	LENS, ENGRAVED				B	0000	EA	3.00	3.00	18-00	001461
04	AML21GBA2AC	SWITCH, (MOM)				B	5 0000	EA	6.00	6.00	19-00	91929 001462
04	86	LAMP, INCANDESCENT				B	5 0000	EA	12.00	12.00	20-00	91929 001463
04	47D387113G1	SECURITY ALARM BOARD				M	0000	EA	1.00	1.00	21-00	001464
05	11-DE-6P	COMPONENT CARD				M	0000	EA	1.00	1.00	1-00	50125 001465
05	E-1	CARD EJECTOR				M	0000	EA	1.00	1.00	2-00	50125 001466
05	T-1SF2-T	WIRE WRAP PIN				B	5 0000	EA	6.00	6.00	3-00	55322 001467
05	AWG-22-TYPE-S	BUS WIRE/QQ-W-343				B	5 0000	FT	AR		4-00	001468
05	47A381044P5	SLEEVING				B	0000	FT	AR		5-00	001469
05	IC-314-WWG	SOCKET, 14 PIN				B	0000	EA	7.00	7.00	6-00	55322 001470
05	IC-316-WWG	SOCKET, 16 PIN				B	0000	EA	3.00	3.00	7-00	55322 001471
05	AP-616-G-E	ADAPTER PLUG				M	0000	EA	2.00	2.00	8-00	55322 001472
05	47D387100	SCHEMATIC				X	0000	EA	X		9-00	001473
05	**47D387113-10	WIRE LIST				X	0000	EA	X		10-00	001474
05	47A380052	ELECTRICAL FAB. STD				X	5 0000	EA	X		11-00	001475
05	SN60WRMAP2	SOLDER / QQ-S-571				B	5 0000	LB	AR		12-00	001476
05	47B381099PAR	WIRE, AWG 30, SLDRLESS				B	0000	FT	AR		13-00	001477
05	1N4148	DIODE				B	7 0000	EA	1.00	1.00	CR1	-00 01295 001478
05	CK06BX103K	CAPACITOR, .01 MFD				B	5 0000	EA	1.00	1.00	C1	-00 95275 001479
05	CK06BX104K	CAPACITOR, .1 MFD				B	5 0000	EA	1.00	1.00	C2	-00 95275 001480
05	CK06BX103K	CAPACITOR, .01 MFD				B	5 0000	EA	1.00	1.00	C3	-00 95275 001481
05	CK06BX473K	CAPACITOR, .47 MFD				B	7 0000	EA	1.00	1.00	C4	-00 001482
05	CK06BX104K	CAPACITOR, .1 MFD				B	5 0000	EA	1.00	1.00	C5	-00 95275 001483
05	RZ-12	RELAY				B	0000	EA	1.00	1.00	K1	-00 05292 001484
05	RCR05G203JS	RESISTOR, 20K				B	0000	EA	1.00	1.00	R1	-00 001485
05	RCR20G681JS	RES, 680 OHMS, 1/2 W				B	5 0000	EA	1.00	1.00	R10	-00 001486
05	RCR05G202JS	RESISTOR, 2K				B	7 0000	EA	1.00	1.00	R11	-00 001487
05	**47D387113-R12	VARISTOR				B	0000	EA	1.00	1.00	R12	-00 001488
05	3009-P-503	POTENTIOMETER, 50K				B	0000	EA	1.00	1.00	R2	-00 32997 001489
05	RCR05G563JS	RESISTOR, 56K				B	0000	EA	1.00	1.00	R3	-00 001490
05	RCR05G203JS	RESISTOR, 20K				B	0000	EA	1.00	1.00	R4	-00 001491
05	3009-P-104	POTENTIOMETER, 100 K				B	0000	EA	1.00	1.00	R5	-00 32997 001492
05	RCR05G753JS	RESISTOR, 75K				B	0000	EA	1.00	1.00	R6	-00 001493
05	RCR07G680JS	RES, 68 OHMS, 1/4 W				B	0000	EA	1.00	1.00	R7	-00 001494
05	RCR05G103JS	RESISTOR, 10K				B	7 0000	EA	1.00	1.00	R8	-00 001495
05	RCR05G103JS	RESISTOR, 10K				B	7 0000	EA	1.00	1.00	R9	-00 001496
05	MC14013BCP	DUAL D FLIP-FLOP				B	0000	EA	1.00	1.00	U1	-00 04713 001497
05	MC14081BCP	QUAD 2-INPUT AND G				M	0000	EA	1.00	1.00	U10	-00 04713 001498
05	MC14541BCP	PROGRAMMABLE OSC-TMR				M	0000	EA	1.00	1.00	U11	-00 04713 001499

LVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C Y	TIME						
05	MC14071BCP	QUAD 2-INPUT OR GATE					M	0000	EA		1.00	1.00	U12	-00 04713 001500
05	MC14490FP	CONTACT DEBOUNCER					B 5	0000	EA		1.00	1.00	U2	-00 04713 001501
05	UNC-4401A	LATCH/DRIVER					B	0000	EA		1.00	1.00	U4	-00 80183 001502
05	MC14528BCP	DUAL MONOSTABLE MV					B	0000	EA		1.00	1.00	U5	-00 04713 001503
05	MC14011BCP	QUAD 2-INPUT NAND G					B	0000	EA		1.00	1.00	U8	-00 04713 001504
05	MC14541BCP	PROGRAMMABLE OSC-TMR					M	0000	EA		1.00	1.00	U9	-00 04713 001505
04	2T1B215	RELAY					B	0000	EA		3.00	3.00	22-00	02289 001506
04	**47E387091-23	PANEL, SIDE					B	0000	EA		1.00	1.00	23-00	001507
04	108-0902-001	BANANA JACK (RED)					B 5	0000	EA		12.00	12.00	26-00	74970 001508
04	108-0903-001	BANANA JACK (BLK)					B 5	0000	EA		12.00	12.00	27-00	74970 001509
04	PT07A-14-5P	RECEPTACLE, JAM NUT					B	0000	EA		1.00	1.00	29-00	77820 001510
04	DBM-25P	CONNECTOR					B 5	0000	EA		2.00	2.00	30-00	71785 001511
04	3341-1L	JACK SOCKET KIT					*	0000	EA		2.00	2.00	31-00	52760 001512
04	47A380052	ELECTRICAL FAB. STD					X 5	0000	EA		X		32-00	001513
04	47E387103	SCHEMATIC					X	0000	EA		X		33-00	001514
04	**47E387091-34	WIRE LIST					X	0000	EA		X		34-00	001515
04	SN60WRMAP2	SOLDER / QQ-S-571					B 5	0000	LB		AR		35-00	001516
04	AWG-22-TYPE-S	BUS WIRE/QQ-W-343					B 5	0000	FT		AR		36-00	001517
04	44A0111-24-9	WIRE, AWG 24					B 5	0000	FT		AR		37-00	06090 001518
04	47A381045P5	CABLE CLAMP					B	0000	EA		3.00	3.00	38-00	001519
04	47A380071PAR	SLEEVEING, SHRINK					*	0000	FT		AR		39-00	001520
04	47A381044PAR	SLEEVEING,TEFLON					*	0000	FT		AR		40-00	001521
04	47A381037P1	LACING TAPE					*	0000	FT		AR		41-00	001522
04	NP-206417	NAMEPLATE					B 5	0000	EA		1.00	1.00	42-00	001523
04	47A380069P31	NAMEPLATE,IDENT (J1)					*	0000	EA		1.00	1.00	43-00	001524
04	47A380069P32	NAMEPLATE,IDENT (J2)					*	0000	EA		1.00	1.00	44-00	001525
04	47A380069P33	NAMEPLATE,IDENT (J3)					B	0000	EA		1.00	1.00	45-00	001526
04	47A380070P3	NPL, AN/REV STATUS					*	0000	EA		1.00	1.00	46-00	001527
04	AWG-20-TYPE-S	WIRE, BUS/QQ-W-343					B	0000	FT		AR		47-00	001528
04	AWG-16-TYPE-S	WIRE, BUS/QQ-W-343					B 5	0000	FT		AR		48-00	001529
04	570-3650-02-01-00	TERMINAL, INSULATED					B 5	0000	EA		8.00	8.00	49-00	71279 001530
04	N153P16007	SCREW, PAN HD					*	0000	EA		4.00	4.00	53-00	001531
04	N153P13005	SCREW, PAN HD					*	0000	EA		15.00	15.00	54-00	001532
04	N415P19	WASHER, LOCK, #10					*	0000	EA		4.00	4.00	55-00	001533
04	N226P16	NUT, HEX, #10-32					*	0000	EA		4.00	4.00	56-00	001534
04	N678P15008	SCREW, FLAT HD					B 5	0000	EA		2.00	2.00	57-00	001535
04	N153P15008	SCREW, PAN HD					B	0000	EA		4.00	4.00	58-00	001536
04	N415P16	WASHER, LOCK, #8					*	0000	EA		6.00	6.00	59-00	001537
04	N226P15	NUT, HEX, #8-32					B 5	0000	EA		2.00	2.00	60-00	001538
04	N153P13004	SCR, PH, #6-32					*	0000	EA		8.00	8.00	61-00	001539
04	N153P13006	SCREW, PAN HD					B	0000	EA		6.00	6.00	62-00	001540
04	N400P37	WASHER, FL #6					*	0000	EA		8.00	8.00	63-00	001541
04	N415P13	WASHER, LOCK, #6					*	0000	EA		29.00	29.00	64-00	001542
04	N226P13	NUT,PLAIN HEX, #6-32					*	0000	EA		21.00	21.00	65-00	001543
03	47E387085G1	ASSY, UTILITY PANEL					M	0000	EA		1.00	1.00	4-00	001544
04	47E387098P1	PANEL, FRONT					M	0000	EA		1.00	1.00	1-00	001545

LVL IDENTIFICATION NO.		NOMENCLATURE	----- ECN -----		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT	APPLY	C	Y	TIME						
04	47E387085P2	PANEL, SIDE				M	0000	EA		2.00		2.00	2-00	001546
04	47C387099P1	PANEL, REAR				M	0000	EA		1.00		1.00	3-00	001547
04	FCA8	HANDLE				B	5 0000	EA		2.00		2.00	4-00 08730	001548
04	108-0902-001	BANANA JACK (RED)				B	5 0000	EA		8.00		8.00	5-00 74970	001549
04	108-0903-001	BANANA JACK (BLK)				B	5 0000	EA		8.00		8.00	6-00 74970	001550
04	DM-3100N	DIGITAL, METER				B	5 0000	EA		3.00		3.00	7-00 50521	001551
04	58-2073082	EDGE CONNECTOR				B	5 0000	EA		3.00		3.00	8-00 50521	001552
04	47D387089G1	ASSY,MTR SIG CONDTNR				M	0000	EA		3.00		3.00	9-00	001553
05	47E387116P1	DRILL & TRIM				M	0000	EA		1.00		3.00	1-00	001554
05	AWG-22-TYPE-S	BUS WIRE/QQ-W-343				B	5 0000	FT		AR			2-00	001555
05	47A381044PAR	SLEEVING,TEFLON				*	0000	FT		AR			3-00	001556
05	IC-314-SGT	SOCKET, 14 PIN				B	0000	EA		2.00		6.00	4-00 55322	001557
05	IC-316-SGT	SOCKET, 16 PIN				B	0000	EA		4.00		12.00	5-00 55322	001558
05	SN60WRMAP2	SOLDER / QQ-S-571				B	5 0000	LB		AR			6-00	001559
05	47D387092	SCHEMATIC				X	0000	EA		X			7-00	001560
05	47A380052	ELECTRICAL FAB. STD				X	5 0000	EA		X			8-00	001561
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR1	-00 01295	001562
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR2	-00 01295	001563
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR3	-00 01295	001564
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR4	-00 01295	001565
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR5	-00 01295	001566
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR6	-00 01295	001567
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR7	-00 01295	001568
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR8	-00 01295	001569
05	1N4148	DIODE				B	7 0000	EA		1.00		3.00 CR9	-00 01295	001570
05	CKR05BX221KR	CAPACITOR, 200 PF				B	0000	EA		1.00		3.00 C1	-00	001571
05	199D106X0010BB1	CAPACITOR, 10 MFD				B	0000	EA		1.00		3.00 C2	-00 56289	001572
05	CKR06BX103KR	CAPACITOR, .01 MFD				B	0000	EA		1.00		3.00 C3	-00	001573
05	CKR06BX104KR	CAPACITOR, .1 MFD				B	0000	EA		1.00		3.00 C4	-00	001574
05	CKR06BX104KR	CAPACITOR, .1 MFD				B	0000	EA		1.00		3.00 C5	-00	001575
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E1	-00 55322	001576
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E10	-00 55322	001577
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E11	-00 55322	001578
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E12	-00 55322	001579
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E13	-00 55322	001580
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E14	-00 55322	001581
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E15	-00 55322	001582
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E16	-00 55322	001583
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E17	-00 55322	001584
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E18	-00 55322	001585
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E19	-00 55322	001586
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E2	-00 55322	001587
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E3	-00 55322	001588
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E4	-00 55322	001589
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E5	-00 55322	001590
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E6	-00 55322	001591
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E7	-00 55322	001592
05	T-1R2-T	TERMINAL				B	0000	EA		1.00		3.00 E8	-00 55322	001593

LVL IDENTIFICATION NO.		NOMENCLATURE	----- ECN -----		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF DESG	FSCM	CROSS REF
			INC	OUT		APPLY	C	Y	TIME						
05	T-1R2-T	TERMINAL					B	0000	EA		1.00	3.00	E9	-00 55322	001594
05	53451-1	RELAY					B	7 0000	EA		1.00	3.00	K1	-00 18342	001595
05	53451-1	RELAY					B	7 0000	EA		1.00	3.00	K2	-00 18342	001596
05	53451-1	RELAY					B	7 0000	EA		1.00	3.00	K3	-00 18342	001597
05	RCR05G102JS	RESISTOR, 1K					B	7 0000	EA		1.00	3.00	R1	-00	001598
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R10	-00	001599
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R11	-00	001600
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R12	-00	001601
05	RNC55H1101FS	RESISTOR, 1.1K					B	5 0000	EA		1.00	3.00	R13	-00	001602
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R14	-00	001603
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R15	-00	001604
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R16	-00	001605
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R17	-00	001606
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R18	-00	001607
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R19	-00	001608
05	RCR05G102JS	RESISTOR, 1K					B	7 0000	EA		1.00	3.00	R2	-00	001609
05	64Y103	POTENTIOMETER, 10K					B	0000	EA		1.00	3.00	R20	-00 02111	001610
05	64Y102	POTENTIOMETER, 1K					B	0000	EA		1.00	3.00	R21	-00 02111	001611
05	64Y103	POTENTIOMETER, 10K					B	0000	EA		1.00	3.00	R22	-00 02111	001612
05	64Y102	POTENTIOMETER, 1K					B	0000	EA		1.00	3.00	R23	-00 02111	001613
05	64Y103	POTENTIOMETER, 10K					B	0000	EA		1.00	3.00	R24	-00 02111	001614
05	64Y102	POTENTIOMETER, 1K					B	0000	EA		1.00	3.00	R25	-00 02111	001615
05	RCR05G102JS	RESISTOR, 1K					B	7 0000	EA		1.00	3.00	R3	-00	001616
05	RCR05G102JS	RESISTOR, 1K					B	7 0000	EA		1.00	3.00	R4	-00	001617
05	RCR05G471JS	RESISTOR, 470					B	7 0000	EA		1.00	3.00	R5	-00	001618
05	RNC55H2490FS	RESISTOR, 249					B	0000	EA		1.00	3.00	R6	-00	001619
05	RNC55H2490FS	RESISTOR, 249					B	0000	EA		1.00	3.00	R7	-00	001620
05	RNC55H2490FS	RESISTOR, 249					B	0000	EA		1.00	3.00	R8	-00	001621
05	RNC55H1002FS	RESISTOR					B	5 0000	EA		1.00	3.00	R9	-00	001622
05	SN7475N	4-BIT BISTABLE LCH					B	5 0000	EA		1.00	3.00	U1	-00 01295	001623
05	UHP-407	DRIVER					B	7 0000	EA		1.00	3.00	U2	-00 56289	001624
05	TLO84CN	QUAD JFET OPNL AMPL					B	7 0000	EA		1.00	3.00	U3	-00 01295	001625
04	AML12CBC3AA	SWITCH, (MOM)					B	0000	EA		8.00	8.00	10-00	91929	001626
04	**47E387085-11	LENS, ENGRAVED					M	0000	EA		1.00	1.00	11-00		001627
04	**47E387085-12	LENS, ENGRAVED					M	0000	EA		1.00	1.00	12-00		001628
04	**47E387085-13	LENS, ENGRAVED					M	0000	EA		1.00	1.00	13-00		001629
04	**47E387085-14	LENS, ENGRAVED					M	0000	EA		1.00	1.00	14-00		001630
04	**47E387085-15	LENS, ENGRAVED					M	0000	EA		1.00	1.00	15-00		001631
04	**47E387085-16	LENS, ENGRAVED					M	0000	EA		1.00	1.00	16-00		001632
04	**47E387085-17	LENS, ENGRAVED					M	0000	EA		1.00	1.00	17-00		001633
04	**47E387085-18	LENS, ENGRAVED					M	0000	EA		1.00	1.00	18-00		001634
04	D8-25P	CONNECTOR, 25 PIN					B	5 0000	EA		1.00	1.00	19-00	71785	001635
04	47A380052	ELECTRICAL FAB. STD					X	5 0000	EA			X	20-00		001636
04	47E387097	SCHEMATIC					X	0000	EA			X	21-00		001637
04	**47E387085-22	WIRE LIST					X	0000	EA			X	22-00		001638
04	AWG-22-TYPE-S	BUS WIRE/QQ-W-343					B	5 0000	FT		AR		23-00		001639
04	44A0111-24-9	WIRE, AWG 24					B	5 0000	FT		AR		24-00	06090	001640
04	47A381045P5	CABLE CLAMP					B	0000	EA		3.00	3.00	25-00		001641

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG INC	OUT	PL-LATE APPLY	P T C Y	CYCLE TIME	U/M	PL-QTY	EXT/TOT	QTY	ITEM/ REF	DESG	FSCM	CROSS REF
04	47A380071PAR	SLEEVING, SHRINK	*	0000	FT							AR			26-00		001642
04	47A381044PAR	SLEEVING,TEFLON	*	0000	FT							AR			27-00		001643
04	47A381037P1	LACING TAPE	*	0000	FT							AR			28-00		001644
04	NP-206417	NAMEPLATE	B	5	0000	EA					1.00		1.00		29-00		001645
04	47A380069P31	NAMEPLATE,IDENT (J1)	*	0000	EA						1.00		1.00		30-00		001646
04	47A380069P32	NAMEPLATE,IDENT (J2)	*	0000	EA						1.00		1.00		31-00		001647
04	47A380070P3	NPL, AN/REV STATUS	*	0000	EA						1.00		1.00		32-00		001648
04	AWG-20-TYPE-S	WIRE, BUS/QQ-W-343	B	0000	FT							AR			33-00		001649
04	PT07A-14-5P	RECEPTACLE, JAM NUT	B	0000	EA						1.00		1.00		34-00	77820	001650
04	570-3650-02-01-00	TERMINAL, INSULATED	B	5	0000	EA					8.00		8.00		35-00	71279	001651
04	3341-1L	JACK SOCKET KIT	*	0000	EA						1.00		1.00		36-00	52760	001652
04	AWG-16-TYPE-S	WIRE, BUS/QQ-W-343	B	5	0000	FT						AR			37-00		001653
04	N153P13005	SCREW, PAN HD	*	0000	EA						3.00		3.00		38-00		001654
04	N415P19	WASHER, LOCK, #10	*	0000	EA						4.00		4.00		39-00		001655
04	N226P16	NUT, HEX, #10-32	*	0000	EA						4.00		4.00		40-00		001656
04	N153P16007	SCREW, PAN HD	*	0000	EA						4.00		4.00		41-00		001657
04	N153P15008	SCREW, PAN HD	B	0000	EA						4.00		4.00		42-00		001658
04	N415P16	WASHER, LOCK, #8	*	0000	EA						6.00		6.00		43-00		001659
04	N678P15008	SCREW, FLAT HD	B	5	0000	EA					2.00		2.00		44-00		001660
04	N226P15	NUT, HEX, #8-32	B	5	0000	EA					2.00		2.00		45-00		001661
04	N415P13	WASHER, LOCK, #6	*	0000	EA						11.00		11.00		46-00		001662
04	N153P13004	SCR, PH, #6-32	*	0000	EA						8.00		8.00		47-00		001663
04	N400P37	WASHER, FL. #6	*	0000	EA						8.00		8.00		48-00		001664
04	N226P13	NUT,PLAIN HEX, #6-32	*	0000	EA						3.00		3.00		49-00		001665
03	47E387084G1	ASSY, STATUS PANEL	M	0000	EA						1.00		1.00		5-00		001666
04	47E387104P1	PANEL, FRONT	B	0000	EA						1.00		1.00		1-00		001667
04	47E387084P2	PANEL, SIDE	B	0000	EA						2.00		2.00		2-00		001668
04	47D387106P1	PANEL, REAR	B	0000	EA						1.00		1.00		3-00		001669
04	FCA4	HANDLE	B	5	0000	EA					2.00		2.00		4-00	08730	001670
04	47D387107P1	SGL CD FR.,MODIFIED	B	0000	EA						1.00		1.00		5-00		001671
04	47D387108P1	BRACKET, CARD FRAME	B	0000	EA						1.00		1.00		6-00		001672
04	DM-3100N	DIGITAL, METER	B	5	0000	EA					5.00		5.00		7-00	50521	001673
04	58-2073082	EDGE CONNECTOR	B	5	0000	EA					5.00		5.00		8-00	50521	001674
04	47D387089G1	ASSY,MTR SIG CONDTNR	M	0000	EA						5.00		5.00		9-00		001675
05	47E387116P1	DRILL & TRIM	M	0000	EA						1.00		5.00		1-00		001676
05	AWG-22-TYPE-S	BUS WIRE/QQ-W-343	B	5	0000	FT						AR			2-00		001677
05	47A381044PAR	SLEEVING,TEFLON	*	0000	FT							AR			3-00		001678
05	IC-314-SGT	SOCKET, 14 PIN	B	0000	EA						2.00		10.00		4-00	55322	001679
05	IC-316-SGT	SOCKET, 16 PIN	B	0000	EA						4.00		20.00		5-00	55322	001680
05	SN60WRMAP2	SOLDER / QQ-S-571	B	5	0000	LB						AR			6-00		001681
05	47D387092	SCHEMATIC	X	0000	EA							X			7-00		001682
05	47A380052	ELECTRICAL FAB. STD	X	5	0000	EA						X			8-00		001683
05	1N4148	DIODE	B	7	0000	EA					1.00		5.00	CR1	-00	01295	001684
05	1N4148	DIODE	B	7	0000	EA					1.00		5.00	CR2	-00	01295	001685
05	1N4148	DIODE	B	7	0000	EA					1.00		5.00	CR3	-00	01295	001686
05	1N4148	DIODE	B	7	0000	EA					1.00		5.00	CR4	-00	01295	001687

LVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG INC OUT	PL-LATE APPLY	P T C Y	CYCLE TIME	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
05	1N4148	DIODE					B 7	0000	EA	1.00	5.00	CR5	-00 01295 001688
05	1N4148	DIODE					B 7	0000	EA	1.00	5.00	CR6	-00 01295 001689
05	1N4148	DIODE					B 7	0000	EA	1.00	5.00	CR7	-00 01295 001690
05	1N4148	DIODE					B 7	0000	EA	1.00	5.00	CR8	-00 01295 001691
05	1N4148	DIODE					B 7	0000	EA	1.00	5.00	CR9	-00 01295 001692
05	CKR05BX221KR	CAPACITOR, 200 PF					B	0000	EA	1.00	5.00	C1	-00 001693
05	199D106X0010BB1	CAPACITOR, 10 MFD					B	0000	EA	1.00	5.00	C2	-00 56289 001694
05	CKR06BX103KR	CAPACITOR, .01 MFD					B	0000	EA	1.00	5.00	C3	-00 001695
05	CKR06BX104KR	CAPACITOR, .1 MFD					B	0000	EA	1.00	5.00	C4	-00 001696
05	CKR06BX104KR	CAPACITOR, .1 MFD					B	0000	EA	1.00	5.00	C5	-00 001697
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E1	-00 55322 001698
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E10	-00 55322 001699
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E11	-00 55322 001700
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E12	-00 55322 001701
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E13	-00 55322 001702
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E14	-00 55322 001703
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E15	-00 55322 001704
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E16	-00 55322 001705
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E17	-00 55322 001706
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E18	-00 55322 001707
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E19	-00 55322 001708
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E2	-00 55322 001709
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E3	-00 55322 001710
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E4	-00 55322 001711
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E5	-00 55322 001712
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E6	-00 55322 001713
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E7	-00 55322 001714
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E8	-00 55322 001715
05	T-1R2-T	TERMINAL					B	0000	EA	1.00	5.00	E9	-00 55322 001716
05	53451-1	RELAY					B 7	0000	EA	1.00	5.00	K1	-00 18342 001717
05	53451-1	RELAY					B 7	0000	EA	1.00	5.00	K2	-00 18342 001718
05	53451-1	RELAY					B 7	0000	EA	1.00	5.00	K3	-00 18342 001719
05	RCR05G102JS	RESISTOR, 1K					B 7	0000	EA	1.00	5.00	R1	-00 001720
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R10	-00 001721
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R11	-00 001722
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R12	-00 001723
05	RNC55H1101FS	RESISTOR, 1.1K					B 5	0000	EA	1.00	5.00	R13	-00 001724
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R14	-00 001725
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R15	-00 001726
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R16	-00 001727
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R17	-00 001728
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R18	-00 001729
05	RNC55H1002FS	RESISTOR					B 5	0000	EA	1.00	5.00	R19	-00 001730
05	RCR05G102JS	RESISTOR, 1K					B 7	0000	EA	1.00	5.00	R2	-00 001731
05	64Y103	POTENTIOMETER, 10K					B	0000	EA	1.00	5.00	R20	-00 02111 001732
05	64Y102	POTENTIOMETER, 1K					B	0000	EA	1.00	5.00	R21	-00 02111 001733
05	64Y103	POTENTIOMETER, 10K					B	0000	EA	1.00	5.00	R22	-00 02111 001734
05	64Y102	POTENTIOMETER, 1K					B	0000	EA	1.00	5.00	R23	-00 02111 001735
05	64Y103	POTENTIOMETER, 10K					B	0000	EA	1.00	5.00	R24	-00 02111 001736

LVL	IDENTIFICATION NO.	NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			INC	OUT		APPLY	C Y	TIME					
05	64Y102	POTENTIOMETER, 1K					B	0000	EA	1.00	5.00	R25	-00 02111 001737
05	RCR05G102JS	RESISTOR, 1K					B	7 0000	EA	1.00	5.00	R3	-00 001738
05	RCR05G102JS	RESISTOR, 1K					B	7 0000	EA	1.00	5.00	R4	-00 001739
05	RCR05G471JS	RESISTOR, 470					B	7 0000	EA	1.00	5.00	R5	-00 001740
05	RNC55H2490FS	RESISTOR, 249					B	0000	EA	1.00	5.00	R6	-00 001741
05	RNC55H2490FS	RESISTOR, 249					B	0000	EA	1.00	5.00	R7	-00 001742
05	RNC55H2490FS	RESISTOR, 249					B	0000	EA	1.00	5.00	R8	-00 001743
05	RNC55H1002FS	RESISTOR					B	5 0000	EA	1.00	5.00	R9	-00 001744
05	SN7475N	4-BIT BISTABLE LCH					B	5 0000	EA	1.00	5.00	U1	-00 01295 001745
05	UHP-407	DRIVER					B	7 0000	EA	1.00	5.00	U2	-00 56289 001746
05	TLOB4CN	QUAD JFET OPNL AMPL					B	7 0000	EA	1.00	5.00	U3	-00 01295 001747
04	AML12CBC3AA	SWITCH, (MOM)					B	0000	EA	15.00	15.00	10-00	91929 001748
04	**47E387084-11	LENS, ENGRAVED					M	0000	EA	2.00	2.00	11-00	001749
04	**47E387084-12	LENS, ENGRAVED					B	0000	EA	2.00	2.00	12-00	001750
04	**47E387084-13	LENS, ENGRAVED					B	0000	EA	2.00	2.00	13-00	001751
04	**47E387084-14	LENS, ENGRAVED					B	0000	EA	1.00	1.00	14-00	001752
04	**47E387084-15	LENS, ENGRAVED					B	0000	EA	1.00	1.00	15-00	001753
04	**47E387084-16	LENS, ENGRAVED					B	0000	EA	1.00	1.00	16-00	001754
04	**47E387084-17	LENS, ENGRAVED					B	0000	EA	1.00	1.00	17-00	001755
04	AML21GBA2AC	SWITCH, (MOM)					B	5 0000	EA	1.00	1.00	18-00	91929 001756
04	AML27ABK2ACO2AA	SWITCH, KEY					B	0000	EA	1.00	1.00	19-00	91929 001757
04	86	LAMP, INCANDESCENT					B	5 0000	EA	2.00	2.00	20-00	91929 001758
04	**47E387084-21	LENS, ENGRAVED					B	0000	EA	1.00	1.00	21-00	001759
04	**47E387084-22	LENS, ENGRAVED					B	0000	EA	1.00	1.00	22-00	001760
04	SNP-428	ALARM					B	5 0000	EA	1.00	1.00	23-00	90201 001761
04	PW1	WASHER, COMPRESSION					B	5 0000	EA	1.00	1.00	24-00	90201 001762
04	47D387113G1	SECURITY ALARM BOARD					M	0000	EA	1.00	1.00	25-00	001763
05	11-DE-6P	COMPONENT CARD					M	0000	EA	1.00	1.00	1-00	50125 001764
05	E-1	CARD EJECTOR					M	0000	EA	1.00	1.00	2-00	50125 001765
05	T-15F2-T	WIRE WRAP PIN					B	5 0000	EA	6.00	6.00	3-00	55322 001766
05	AWG-22-TYPE-S	BUS WIRE/QQ-W-343					B	5 0000	FT	AR		4-00	001767
05	47A381044P5	SLEEVING					B	0000	FT	AR		5-00	001768
05	IC-314-WWG	SOCKET, 14 PIN					B	0000	EA	7.00	7.00	6-00	55322 001769
05	IC-316-WWG	SOCKET, 16 PIN					B	0000	EA	3.00	3.00	7-00	55322 001770
05	AP-616-G-E	ADAPTER PLUG					M	0000	EA	2.00	2.00	8-00	55322 001771
05	47D387100	SCHEMATIC					X	0000	EA	X		9-00	001772
05	**47D387113-10	WIRE LIST					X	0000	EA	X		10-00	001773
05	47A380052	ELECTRICAL FAB. STD					X	5 0000	EA	X		11-00	001774
05	SN60WRMAP2	SOLDER / QQ-S-571					B	5 0000	LB	AR		12-00	001775
05	47B381099PAR	WIRE, AWG 30, SLDRLSS					B	0000	FT	AR		13-00	001776
05	1N4148	DIODE					B	7 0000	EA	1.00	1.00	CR1	-00 01295 001777
05	CK06BX103K	CAPACITOR, .01 MFD					B	5 0000	EA	1.00	1.00	C1	-00 95275 001778
05	CK06BX104K	CAPACITOR, .1 MFD					B	5 0000	EA	1.00	1.00	C2	-00 95275 001779
05	CK06BX103K	CAPACITOR, .01 MFD					B	5 0000	EA	1.00	1.00	C3	-00 95275 001780
05	CK06BX473K	CAPACITOR, .47 MFD					B	7 0000	EA	1.00	1.00	C4	-00 001781
05	CK06BX104K	CAPACITOR, .1 MFD					B	5 0000	EA	1.00	1.00	C5	-00 95275 001782
05	RZ-12	RELAY					B	0000	EA	1.00	1.00	K1	-00 05292 001783

LVL	IDENTIFICATION NO.	NOMENCLATURE	----- ECN -----		PL-LATE INC OUT	P T C Y	CYCLE U/M	PL-QTY	EXT/TOT QTY	ITEM/ REF DESG	FSCM CROSS REF
			DWG	APPLY							
05	RCR05G203JS	RESISTOR, 20K			B	0000	EA	1.00	1.00	R1	-00 001784
05	RCR20G681JS	RES, 680 OHMS, 1/2 W			B 5	0000	EA	1.00	1.00	R10	-00 001785
05	RCR05G202JS	RESISTOR, 2K			B 7	0000	EA	1.00	1.00	R11	-00 001786
05	**47D387113-R12	VARISTOR			B	0000	EA	1.00	1.00	R12	-00 001787
05	3009-P-503	POTENTIOMETER, 50K			B	0000	EA	1.00	1.00	R2	-00 32997 001788
05	RCR05G563JS	RESISTOR, 56K			B	0000	EA	1.00	1.00	R3	-00 001789
05	RCR05G203JS	RESISTOR, 20K			B	0000	EA	1.00	1.00	R4	-00 001790
05	3009-P-104	POTENTIOMETER, 100 K			B	0000	EA	1.00	1.00	R5	-00 32997 001791
05	RCR05G753JS	RESISTOR, 75K			B	0000	EA	1.00	1.00	R6	-00 001792
05	RCR07G680JS	RES, 68 OHMS, 1/4 W			B	0000	EA	1.00	1.00	R7	-00 001793
05	RCR05G103JS	RESISTOR, 10K			B 7	0000	EA	1.00	1.00	R8	-00 001794
05	RCR05G103JS	RESISTOR, 10K			B 7	0000	EA	1.00	1.00	R9	-00 001795
05	MC14013BCP	DUAL D FLIP-FLOP			B	0000	EA	1.00	1.00	U1	-00 04713 001796
05	MC14081BCP	QUAD 2-INPUT AND G			M	0000	EA	1.00	1.00	U10	-00 04713 001797
05	MC14541BCP	PROGRAMMABLE OSC-TMR			M	0000	EA	1.00	1.00	U11	-00 04713 001798
05	MC14071BCP	QUAD 2-INPUT OR GATE			M	0000	EA	1.00	1.00	U12	-00 04713 001799
05	MC14490FP	CONTACT DEBOUNCER			B 5	0000	EA	1.00	1.00	U2	-00 04713 001800
05	UNC-4401A	LATCH/DRIVER			B	0000	EA	1.00	1.00	U4	-00 80183 001801
05	MC14528BCP	DUAL MONOSTABLE MV			B	0000	EA	1.00	1.00	U5	-00 04713 001802
05	MC14011BCP	QUAD 2-INPUT NAND G			B	0000	EA	1.00	1.00	U8	-00 04713 001803
05	MC14541BCP	PROGRAMMABLE OSC-TMR			M	0000	EA	1.00	1.00	U9	-00 04713 001804
04	108-0902-001	BANANA JACK (RED)			B 5	0000	EA	15.00	15.00	26-00	74970 001805
04	108-0903-001	BANANA JACK (BLK)			B 5	0000	EA	15.00	15.00	27-00	74970 001806
04	**47E387084-28	LENS, ENGRAVED			B	0000	EA	1.00	1.00	28-00	001807
04	PT07A-14-5P	RECEPTACLE, JAM NUT			B	0000	EA	1.00	1.00	29-00	77820 001808
04	DBM-25P	CONNECTOR			B 5	0000	EA	2.00	2.00	30-00	71785 001809
04	3341-1L	JACK SOCKET KIT			*	0000	EA	2.00	2.00	31-00	52760 001810
04	47A380052	ELECTRICAL FAB. STD			X 5	0000	EA	X	X	32-00	001811
04	47E387101	SCHEMATIC			X	0000	EA	X	X	33-00	001812
04	**47E387084-34	WIRE LIST			X	0000	EA	X	X	34-00	001813
04	SN60WRMAP2	SOLDER / QQ-S-571			B 5	0000	LB	AR	AR	35-00	001814
04	AWG-22-TYPE-S	BUS WIRE/QQ-W-343			B 5	0000	FT	AR	AR	36-00	001815
04	44A0111-24-9	WIRE, AWG 24			B 5	0000	FT	AR	AR	37-00	06090 001816
04	47A381045P5	CABLE CLAMP			B	0000	EA	3.00	3.00	38-00	001817
04	47A380071PAR	SLEEVING, SHRINK			*	0000	FT	AR	AR	39-00	001818
04	47A381044PAR	SLEEVING, TEFLON			*	0000	FT	AR	AR	40-00	001819
04	47A381037P1	LACING TAPE			*	0000	FT	AR	AR	41-00	001820
04	NP-206417	NAMEPLATE			B 5	0000	EA	1.00	1.00	42-00	001821
04	47A380069P31	NAMEPLATE, IDENT (J1)			*	0000	EA	1.00	1.00	43-00	001822
04	47A380069P32	NAMEPLATE, IDENT (J2)			*	0000	EA	1.00	1.00	44-00	001823
04	47A380069P33	NAMEPLATE, IDENT (J3)			B	0000	EA	1.00	1.00	45-00	001824
04	47A380070P3	NPL, AN/REV STATUS			*	0000	EA	1.00	1.00	46-00	001825
04	AWG-20-TYPE-S	WIRE, BUS/QQ-W-343			B	0000	FT	AR	AR	47-00	001826
04	AWG-16-TYPE-S	WIRE, BUS/QQ-W-343			B 5	0000	FT	AR	AR	48-00	001827
04	570-3650-02-01-00	TERMINAL, INSULATED			B 5	0000	EA	8.00	8.00	49-00	71279 001828
04	**47E387084-50	LENS, ENGRAVED			B	0000	EA	1.00	1.00	50-00	001829
04	**47E387084-51	LENS, ENGRAVED			B	0000	EA	1.00	1.00	51-00	001830
04	**47E387084-52	LENS, ENGRAVED			B	0000	EA	2.00	2.00	52-00	001831

LVL IDENTIFICATION NO.		NOMENCLATURE	ECN		DWG	PL-LATE	P T	CYCLE	U/M	PL-QTY	EXT/TOT	QTY	ITEM/	FSCM	CROSS
			INC	OUT	APPLY	C	Y	TIME					REF	DESG	REF
04	N153P16007	SCREW, PAN HD				*		0000	EA		4.00	4.00	53-00		001832
04	N153P13005	SCREW, PAN HD				*		0000	EA		3.00	3.00	54-00		001833
04	N415P19	WASHER, LOCK, #10				*		0000	EA		4.00	4.00	55-00		001834
04	N226P16	NUT, HEX, #10-32				*		0000	EA		4.00	4.00	56-00		001835
04	N678P15008	SCREW, FLAT HD				B	5	0000	EA		2.00	2.00	57-00		001836
04	N153P15008	SCREW, PAN HD				B		0000	EA		4.00	4.00	58-00		001837
04	N415P16	WASHER, LOCK, #8				*		0000	EA		4.00	4.00	59-00		001838
04	N226P15	NUT, HEX, #8-32				B	5	0000	EA		2.00	2.00	60-00		001839
04	N153P13004	SCR, PH, #6-32				*		0000	EA		8.00	8.00	61-00		001840
04	N153P13006	SCREW, PAN HD				B		0000	EA		6.00	6.00	62-00		001841
04	N400P37	WASHER, FL. #6				*		0000	EA		8.00	8.00	63-00		001842
04	N415P13	WASHER, LOCK, #6				*		0000	EA		17.00	17.00	64-00		001843
04	N226P13	NUT, PLAIN HEX, #6-32				*		0000	EA		9.00	9.00	65-00		001844
04	**47E387084-66	LENS, ENGRAVED				B		0000	EA		1.00	1.00	66-00		001845
04	AML52-N10W	LENS				B		0000	EA		1.00	1.00	67-00	91929	001846
04	47A380102	FINISH				X		0000	PT		X		68-00		001847
03	**47E387112-6	COMM PANEL				M		0000	EA		1.00	1.00	6-00		001848
03	47A380030	SPEC, SYST DISP PNL				X		0000	EA		X		7-00		001849
03	**47E387112-8	BLOWER, 130 CFM				B		0000	EA		1.00	1.00	8-00		001850
03	**47E387112-9	BLOWER				B		0000	EA		1.00	1.00	9-00		001851
03	**47E387112-10	ENCLOSURE, FRAME				M		0000	EA		1.00	1.00	10-00		001852
03	**47E387112-11	AIR EXHAUST UNIT L.H				B		0000	EA		1.00	1.00	11-00		001853
03	**47E387112-12	AIR EXHAUST UNIT R.H				B		0000	EA		1.00	1.00	12-00		001854
03	**47E387112-13	SCHEMATIC				X		0000	EA		X		13-00		001855
03	**47E387112-14	CABLE ASSY				X		0000	EA		X		14-00		001856
03	**47E387112-15	WIRE LIST				X		0000	EA		X		15-00		001857
02	**47E387081-19	C.D.S. OPR TERMINAL				M		0000	EA		1.00	1.00	19-00		001858
02	47E387018	POWER DISTBR SCHEM				X		0000	EA		X		20-00		001859
02	**47E387081-21	EYE WASH STATION				M		0000	EA		1.00	1.00	21-00		001860
02	**47E387081-22	EMER LIGHT UNIT				M		0000	EA		3.00	3.00	22-00		001861
02	**47E387081-23	FIRE EXT UNIT				M		0000	EA		5.00	5.00	23-00		001862
02	**47E387081-24	TEL & SITE INTERCOM				M		0000	EA		1.00	1.00	24-00		001863
02	47A380094	7500KVA VAR SP GEN				X		0000	EA		X		25-00		001864
01	47E387114	CONTROL SYSTEM SCHEM				X		0000	EA		X		10-00		001865
01	47A380023	POWER CABLING REQ				X		0000	EA		X		11-00		001866
01	47A380024	INSTL CABLING REQ				X		0000	EA		X		12-00		001867
01	47A380008	STEP-UP XFMR SPEC				X		0000	EA		X		13-00		001868
01	47A387005	I&C SIGNAL LIST				X		0000	EA		X		14-00		001869
01	47D382288	GENERAL SITE LCTN				X		0000	EA		X		15-00		001870
01	47D382298	SITE PLAN-1ST UNIT				X		0000	EA		X		16-00		001871
01	47E387014	SCHEM, NACELLE, GEN				X		0000	EA		X		17-00		001872
01	47D382000	TOWER GEOMETRY/DIAG				X		0000	EA		X		18-00		001873
01	47D382274	NACELLE GEOMETRY				X		0000	EA		X		19-00		001874

IDENTIFICATION NO.	NOMENCLATURE	--- ECN ---		PL-LATE APPLY	P C	T Y	CYCLE TIME	FSCM U/M	NEXT HIGHER ASSEMBLY	QTY	EXT/TOT-QTY	CROSS REF
		DWG INC	OUT									
300H1-15CG-04-K	PRESSURE TRANSDUCER				B		0000 89326	EA	47J382313G1	03.000	03.000	000103
3009-P-104	POTENTIOMETER, 100 K				B		0000 32997	EA	47D387113G1	02.000	02.000	001492
3009-P-503	POTENTIOMETER, 50K				B		0000 32997	EA	47D387113G1	02.000	02.000	001788
3009P-1-102	POTENTIOMETER, 1 K				B	7	0000 32997	EA	47E387037G1	01.000	02.000	000720
3009P-1-202	POTENTIOMETER, 2 K				B		0000 32997	EA	47E387037G1	02.000	04.000	000715
3009P-1-501	POTENTIOMTR 500 OHMS				B		0000 32997	EA	47E387037G1	04.000	08.000	000718
3043T18	"U" BOLT & NUTS				B	5	0000 39428	EA	47J382313G1	06.000	06.000	000080
3059J-1-102M	POTENTIOMETER				M		0000 32997	EA	47D387130G1	02.000	02.000	000894
326T-FRAME	MOTOR, TEFC				B		0000	EA	47E382579G1	01.000	01.000	000471
3302-37	CABLE 12" LG				*		0000 75037	EA	47D387087G1	01.000	07.000	000741
3341-1L	JACK SOCKET KIT				*		0000 52760	EA	47E387072G1	07.000	07.000	000742
3341-1L	JACK SOCKET KIT				*		0000 52760	EA	47E387084G1	02.000	02.000	001810
3341-1L	JACK SOCKET KIT				*		0000 52760	EA	47E387085G1	01.000	01.000	001652
3341-1L	JACK SOCKET KIT				*		0000 52760	EA	47E387091G1	02.000	02.000	001512
3341-1L	JACK SOCKET KIT				*		0000 52760	EA	47E387095G1	04.000	04.000	000623
											16.000	
3417-7040	CONNECTOR				B	5	0000 75037	EA	47D387087G1	01.000	07.000	000740
3432-4205	HEADER				*		0000 52760	EA	47D387083G1	10.000	10.000	000658
350-SERIES-3DC	PUMP				B		0000 59180	EA	47E382579G1	01.000	01.000	000470
3502-1000	CONNECTOR				*		0000 75037	EA	47D387087G1	01.000	07.000	000739
3596A-3	TERMINAL BOARD				*		0000 75382	EA	47E387072G1	01.000	01.000	000745
3596A-3	TERMINAL BOARD				*		0000 75382	EA	47E387095G1	01.000	01.000	000608
											02.000	
47A380008	STEP-UP XFMR SPEC				X		0000	EA	47E382304G1	X		001868
47A380009	DES. REQMTS, ROTOR BL				X		0000	EA	47E382400G1	X		001118
47A380009	DES. REQMTS, ROTOR BL				X		0000	EA	47E382590G1	X		001224
											00.000	
47A380014	STATION BATTERY SPEC				M		0000	EA	47E387081G1	01.000	01.000	001317
47A380023	POWER CABLING REQ				X		0000	EA	47E382304G1	X		001866

REV NO.	TITLE	CONT ON SHEET	SH NO.
47A380074	MOD-5A WTG PROGRAM QUALITY ASSURANCE REQUIREMENTS FOR THE CONTROL OF RAW MATERIALS AND THE BLADE FABRICATION PROCESS	11	1
CONT ON SHEET	FIRST MADE FOR		

MOD-5A WTG PROGRAM
QUALITY ASSURANCE REQUIREMENTS
FOR THE CONTROL OF
RAW MATERIALS AND THE BLADE FABRICATION PROCESS

A. Cheddar
Q. C. Engineer

DATE: 12/15/82

H. Straub
Test Engineer

DATE: Dec 15, 1982

S. H. ...
Mgr., Subcontracts

DATE: 12/16/82

J. C. ...
Mgr., Design Engineering

DATE: 12/17/82

J. E. ...
Mgr., Integration & Test

DATE: _____

L. H. ... for L. Terrey
Program Manager

DATE: 12/17/82

TOTAL NUMBER OF PAGES 17

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(0913A)

WTG
500
PRINTS TO

MADE BY	APPROVALS	DIV OR DEPT.	47A380074
A. Cheddar	<u>A. E. P.</u>		
ISSUED	KING OF PRUSSIA, PA.	LOCATION	CONT ON SHEET 11 SH NO. 1
<u>A. E. P.</u> 1/18/83			

REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

<u>Revision</u>	<u>Page No.</u>	<u>Paragraph Number(s) Affected</u>	<u>Rev. Date</u>	<u>Approval</u>
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SECTION 1

INTRODUCTION

1.1 PURPOSE

The purpose of this document is to establish minimum quality requirements which must be implemented by the blade manufacturer to insure the minimum acceptable level of control over the blade fabrication process and the raw materials utilized therein.

1.2 SCOPE

The requirements specified herein are intended for controlling all MOD-5A fabrication (development and prime) and are to be implemented by the manufacturer immediately. Non-compliance by the manufacturer may result in QA rejection of all items fabricated during the period between the issue of this specification and the implementation of these requirements.

SECTION 2.0
APPLICABLE DOCUMENTS

2.1 DRAWINGS AND SPECIFICATIONS

Appropriate detailed drawings or specifications applicable to the material or component being manufactured.

SECTION 3.0
REQUIREMENTS

3.1 EPOXY MATERIALS

- 3.1.1 Assign specification numbers and revision numbers to the specifications for each of the materials purchased. These shall be controlled documents and shall be changed only through a formal design change system.
- 3.1.2 The Purchase Order (P.O.) for materials shall reference the specification number and the revision number of the material being purchased.
- 3.1.3 The P.O. shall specify certification and/or test results to be supplied by the vendor.
 - a. Epoxide Equivalent Weight (EEW)
 - b. Viscosity
 - c. Color
 - d. Hydrolyzable Chloride
- 3.1.4 The material is to be identified by a lot or batch number and traceable to the P.O. on which purchased.
- 3.1.5 The P.O. shall have an inspection code indicating what inspections or tests are to be performed in incoming inspection.
 - a. Viscosity
 - b. Color

3.1 EPOXY MATERIALS (continued)

- 3.1.6 Material shall be held in a quarantine area until certifications have been received and incoming inspections and/or tests have been completed. A quarantine area is a controlled area where materials awaiting certifications, test results, or Material Review Board (MRB) disposition may be kept safely and with no danger of being inadvertently mixed with prime materials.
- 3.1.7 If certifications and inspections are satisfactory, the material shall be released to bonded stock or to production.
- 3.1.8 If certifications and inspections are not satisfactory, a Nonconformance Report (NR) will be written and the material will be held in quarantine until a disposition has been made by the Material Review Board (MRB).
- 3.1.9 Certifications, inspection data, P.O. copy, etc., will be maintained in QC files for a minimum period of 5 years. At the end of this period, the data shall be delivered to GE.
- 3.1.10 Materials with a limited shelf life shall have the date of manufacture, date of purchase and date of expiration of shelf life recorded for easy reference. Such materials shall be monitored continuously to insure that expired materials are not used in production.

3.1 EPOXY MATERIALS (continued)

3.1.11 Stock records shall indicate lot number, number of barrels or containers, individual container numbers or identification, date received, P.O. number, date withdrawn, amount withdrawn, job number to be used on. If a partial lot is withdrawn, care shall be taken to insure that all portions are identified to the original lot number or lot I.D.

3.1.12 When individual ingredients are mixed for use in production, an identifying number will be assigned to each batch or lot mixed. The lot numbers of all the individual ingredients used in this batch or lot shall be recorded and shall be traceable to this lot. Samples (5) of the mixed lot will be taken, identified with the appropriate lot I.D. number and tested to verify properties of the mixed lot.

- a. Hardness
- b. Gel Time
- c. Color

3.2 VENEER

3.2.1 Assign specification numbers and revision numbers to the specifications for each of the materials purchased. These shall be controlled documents and shall be changed only through a formal design change system.

3.2 VENEER (continued)

3.2.2 The Purchase Order (P.O.) for materials shall reference the specification number and the revision number of the material being purchased.

3.2.3 The P.O. shall specify certification and/or test results to be supplied by the vendor.

a. Moisture Content Test Data

b. Grade - Each sheet shall be marked to indicate its grade.

Marking shall be per veneer specification and shall be such that material used shall not impair the quality of the bond between adjacent sheets in the marked area.

c. Stiffness

d. Yield by Grade Data

e. Date Dried

f. Date Wrapped and Shipped

3.2.4 The material is to be identified by a lot or batch number and traceable to the P.O. on which purchased.

3.2.5 The P.O. shall have an inspection code indicating what inspections or tests are to be performed in incoming inspection.

a. Moisture Content Samples

b. Ultrasonic Grading Samples

c. Proper Identification and Marking

3.2 VENEER (continued)

- d. Conformance to P.O. Requirements
- e. Proper Packaging per Specification
- f. Shipping Damage

3.2.6 Material shall be held in a quarantine area until certifications have been received and incoming inspections and/or tests have been completed. A quarantine area is a controlled area where materials awaiting certifications, test results, or Material Review Board (MRB) disposition may be kept safely and with no danger of being inadvertently mixed with prime materials.

3.2.7 If certifications and inspections are satisfactory, the material shall be released to bonded stock or to production.

3.2.8 If certifications and inspections are not satisfactory, a Nonconformance Report (NR) will be written and the material will be held in quarantine until a disposition has been made by the Material Review Board (MRB).

3.2.9 Certifications, inspection data, P.O. copy, etc., will be maintained in QC files for a minimum period of 5 years. At the end of this period, the data shall be delivered to GE.

3.2.10 Stock records shall indicate lot number, number of bunks, bunk numbers, date received, date withdrawn, job number (used on), and amount withdrawn. A "Bunk" is a term used to describe a bundle or stack of veneer of normal shipping size, usually between 250 and 300 sheets.

3.2 VENEER (continued)

Note: If a partial lot is withdrawn, the portion withdrawn and the portion remaining must be identified with the appropriate lot number or lot I.D.

3.2.11 When veneer is removed from storage stacks or bunks, moisture content samples representative of the entire bunk will be drawn, checked and recorded (MIN. 10 samples spaced equally from top to bottom of bunk or stack).

3.2.12 When veneer is being used for a "lay-up", an accurate record of "rough-peel" discards will be recorded and filed with data for that lot. A "lay-up" is a preliminary stacking of veneer for a particular job during which each piece of veneer is checked, trimmed to correct size, stacked dry and marked with a layer number and a position number or letter within that layer.

Note: Marking material shall be such that it will not impair the quality of the bond between adjacent sheets.

The veneer is then unstacked, coated with epoxy and returned to the same position in the final assembly that it occupied in the lay-up. "Rough peel" is a term used to describe sheets of veneer with a rougher than normal surface finish. A number of factors may contribute to this condition, included among which are the angle the cutting blade makes with a particular log, moisture content of the log, sharpness of the cutting blade, etc. Sheets of veneer having this abnormally rough finish are discarded. "Rough peel" should be measured rather than arbitrarily and visually determined.

3.2 VENEER (continued)

3.2.13 When more than one bunk of veneer is required for a lay-up, the bunks shall be blended to insure a uniform distribution of veneer from each bunk throughout the lay-up. Each lay-up must be planned on an individual basis after the total number of bunks required and the number of sheets per bunk have been determined. The lay-up is then planned to give the optimum distribution of veneer sheets from the various bunks.

3.3 FABRICATION

- 3.3.1 All fabrication shall be to written instructions describing the detailed operations to be performed in fabricating a billet or blade section.
- 3.3.2 Each individual participating in or contributing to the fabrication process shall be thoroughly familiar with the written instructions and shall be trained in the performance of his functions.
- 3.3.3 A copy of the written instructions shall be available at each work station.
- 3.3.4 A list of all machines, special tools, fixtures, inspection and/or test instrumentation required in the performance and/or monitoring of the process shall be prepared and attached to the process instruction. The process instruction shall include directions for operation and use of each item delineated.

3.3 FABRICATION (continued)

- 3.3.5 Detailed Quality Control inspections and tests shall be incorporated into the Process Instruction. These shall specify the type of inspection or test to be performed, the number of checks to be made or the number of samples to be taken, precise instructions for performing checks or selecting samples, acceptance/rejection criteria for each test or inspection performed, limits of process parameters for satisfactory operation, data to be recorded, ambient shop conditions, etc.
- 3.3.6 Prior to production of any hardware, a Process Readiness Review will be conducted with key personnel from GE serving as members of the Review Board. As a minimum, the Board will consist of representatives from Design Engineering, Quality Control Engineering and Manufacturing Engineering. The Review Team will verify the capability of the process to be performed based on adequate process development, process documentation and controls implemented, tools, equipment and facilities available and verified, personnel properly trained, and first article try-out verified.
- 3.3.7 As a minimum, the fabrication process shall include the following tests and/or inspections:

3.3 FABRICATION (continued)

3.3.7.1 Moisture Content (MC) - As veneer is being removed from a storage stack for use in a preliminary "build-up" or "lay-up", a minimum of ten (10) moisture content samples will be taken from each stack. Samples will be 10" square or 12" square pieces. One sample will be selected from the top layer and one from the bottom layer of the stack. The remaining eight samples will be taken from eight layers equally spaced between the top and bottom of the stack. Samples shall be identified by layer number from which drawn. Raw weight data and calculated values of moisture content shall be recorded for each sample by sample number. Moisture content values for each sample must be within TBD % of the mean for the ten samples taken. In addition, the mean must be within TBD % of the TBD % nominal value of moisture content desired in finished product.

3.3.7.2 Glue Spread Rate - Control parameters (upper and lower limits) for glue spread rates shall be established based on glue machine capability. Sufficient glue spread samples shall be taken at each machine start-up, prior to coating any prime veneer, to insure that glue spread rate is within specified limits and has been stabilized.

3.3 FABRICATION (continued)

3.3.7.2 (continued)

Glue spread samples will be 10" or 12" square pieces of veneer representative of the lot being processed. Spread rate shall be considered stabilized when three successive glue spread samples show rates within TBD % of each other. Each sample shall be identified with the job number being processed plus a consecutive serial number assigned in the order in which each sample was coated. Each sample shall be identified with its dry weight, its specified coated weight and its actual coated weight.

3.3.7.3 Glue Coating - Coating of prime veneer may commence after glue spread rate has been stabilized within process limits. Glue spread samples will be coated at regular intervals throughout the veneer coating cycle. One (1) glue spread sample shall be required for every two hundred and forty (240) square feet of veneer coated. Sample numbers, dry weight, coated weight and glue spread rates shall be recorded on appropriate data sheets and maintained on file with other data for the job being processed.

3.3 FABRICATION (continued)

3.3.7.4 Veneer Stacking - Depending on the size of the job, one or two senior technicians will be assigned responsibility for correctly stacking the coated veneer. He or they shall be responsible to insure that each sheet of veneer is placed in the exact location in which it appeared in the "lay-up". They shall insure that the correct face of the sheet faces upward; that the correct edge of the sheet goes against the stops or guides as appropriate; that sheets butt correctly and do not ride up and over each other; that allowable voids or knotholes are filled with epoxy as required; that sheets having scarfed edges are mated properly; that the number of layers is correct, and that the overall height of the build-up is within drawing dimensional requirements.

3.3.7.5 Vacuum Bagging - After the coated veneer has been properly stacked in the mold or on the table, the build-up shall be bagged and evacuated. To insure proper bagging, elimination of leaks and uniform pressure on the curing build-up, the vacuum inside the bag shall be monitored. A vacuum gage will be placed at each end of the assembly and at a maximum of ten (10) foot intervals along the length of the assembly.

3.3 FABRICATION (continued)

3.3.7.5 (continued)

Each gage will be calibrated against a master or reference gage and shall have an appropriate correction attached or assigned to it. Each gage shall be assigned a number and its number, location, actual reading and corrected reading shall be recorded on appropriate data sheets. Readings shall be taken and recorded at fifteen (15) minute intervals during the first hour after bagging. Readings shall be recorded at one-half (1/2) hour intervals for the next three (3) hours. Starting with the fifth hour, readings shall be recorded at one (1) hour intervals for the remainder of the cure cycle.

3.3.7.6 Ambient Conditions - During the course of a fabrication, the temperature and relative humidity in the shop or work area will be checked at one-half (1/2) hour intervals and recorded with other data for the job.

3.3.8 All data shall be recorded on standard data sheets which have been reviewed and approved for use by GE. All data shall bear the date and the signature of the individual recording the data. Job numbers, serial numbers and any other identifying numbers specified shall be recorded legibly on the data sheets. Data shall be reviewed and signed off by the Quality Control Engineer and stored in Quality Control files. Data shall be maintained on file for a period of at least five (5) years. At the end of this period, the data shall be delivered to GE.

REV NO. A

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FIRST MADE FOR

REVISION

SPECIFICATION

FOR


A THREE STAGE

SPEED INCREASER GEARBOX

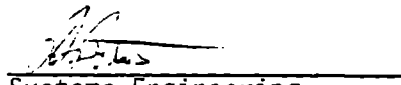
FOR THE MOD-5A WTG

FEBRUARY, 1983

REV "A"
SEPT. 83


Responsible Engineer

DATE: 2/10/83


Systems Engineering

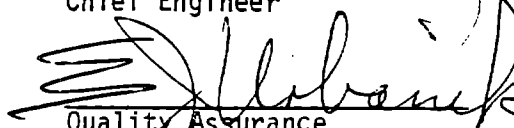
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Engineering Manager

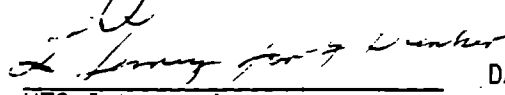
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Chief Engineer

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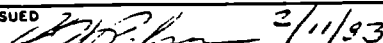
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SECTION 1.0
INTRODUCTION

1.1 SCOPE

This specification establishes the requirements for a speed increaser gearbox and auxiliary equipment. The gearbox will be used as a speed increaser in a wind turbine generator.

SECTION 2.0

APPLICABLE DOCUMENTS

2.1 GENERAL ELECTRIC DRAWINGS AND SPECIFICATIONS

GE Drawing 47E381046 - Gearbox Envelope

GE Specification 47A380048 - Specification for Material Finishes

2.2 STANDARDS

AGMA Aircraft Specification

AFBMA Method of Evaluating Load Ratings for Roller Bearings, Standard
Section #11

AWS-D1.1-76 Structural Welding Code

SSPC-SP10-63T Steel Structures Painting Council Surface Preparation
Specification

SECTION 3.0 REQUIREMENTS

3.1 TYPE

The speed increaser shall be a three stage unit with epicyclic first and second stages and parallel shaft third stage. Input torque to the gearbox is generated by the WTG rotor system. The gearbox in turn will drive a variable speed generator. However, the system will run at two nominal rotor input speeds: 16.8 and 13.7 RPM.

3.2 CONFIGURATION

The overall outline dimensions of this stand-alone speed increaser gearbox shall not exceed those shown in GE Drawing 47E381046.

3.3 WEIGHT

The weight of the speed increaser shall be kept to a minimum, consistent with a cost-effective design.

3.4 PERFORMANCE AND OPERATING CRITERIA

Performance requirements shall be as shown in Table 1. Gearing shall be designed for strength and durability in accordance with applicable AGMA standards for 30 year life under the input torque load spectrum shown in Figure 1 and Table 2.

TABLE 1 -- PERFORMANCE REQUIREMENTS

Input Speed - Nominal	16.8 RPM
Input Speed Range	13.70 RPM to 16.8 RPM
Speed Increaser Ratio	82.14
Rated Input Torque	3.38 x 10 ⁶ ft-lb (10812 HP @ 16.8 RPM) 1.49 x 10 ⁶ ft-lb @ 13.70 RPM
Service Factor	Consistent with 30 year life and duty cycle of Figure 1 and Table 2
Maximum Running Losses	3% at rated power (324 HP @ 16.8 RPM)
Maximum Break-Away Torque	15,000 ft-lb (at low speed shaft)
Duty Cycle	See Table 2
• Maximum No-Load Losses	1.5% of rating at nominal input speed (162 HP @ 16.8 RPM)
Direction of Rotation	Clockwise when looking at the low speed shaft

FIGURE 1

TORQUE/RATED TORQUE	CUMULATIVE PROBABILITY	
	GEARS HAVING RANDOM PHASING	GEARS HAVING FIXED PHASING
.086	0.362E-01	0.659E-02
.173	0.129E-00	0.461E-01
.259	0.248E-00	0.158E-00
.345	0.362E-00	0.270E-00
.388	0.415E-00	0.326E-00
.431	0.464E-00	0.379E-00
.475	0.509E-00	0.428E-00
.518	0.550E-00	0.474E-00
.561	0.587E-00	0.517E-00
.604	0.621E-00	0.557E-00
.647	0.653E-00	0.593E-00
.690	0.682E-00	0.625E-00
.734	0.709E-00	0.655E-00
.777	0.735E-00	0.683E-00
.820	0.761E-00	0.710E-00
.863	0.786E-00	0.736E-00
.906	0.811E-00	0.762E-00
.949	0.836E-00	0.787E-00
.992	0.861E-00	0.812E-00
1.036	0.884E-00	0.838E-00
1.079	0.905E-00	0.863E-00
1.122	0.924E-00	0.887E-00
1.165	0.940E-00	0.909E-00
1.208	0.952E-00	0.928E-00
1.251	0.963E-00	0.943E-00
1.295	0.971E-00	0.955E-00
1.338	0.978E-00	0.965E-00
1.381	0.984E-00	0.973E-00
1.424	0.988E-00	0.980E-00
1.467	0.992E-00	0.985E-00
1.51	0.994E-00	0.989E-00
1.553	0.996E-00	0.993E-00
1.640	0.998E-00	0.997E-00
1.726	0.999E-00	0.999E-00
1.812	0.100E+01	0.999E-01
1.899	0.100E+01	0.100E+01
1.985	0.100E+01	0.100E+01
ROOT MEAN FOURTH LOAD	.921 (WITH 30% MAX OVERLD)	.985 (WITH 30% MAX OVERLD)

RATED TORQUE = 3.38 E6
TOTAL ROTOR CYCLES = 1.78 E8
LOADS CONTAIN 1.15 CONTINGENCY FACTOR

TABLE 2 - GEARBOX TORQUE DUTY CYCLE

3.4.1 Overload Maximum

(a) Design Limit - Static at 200% of rated torque, 5 occurrences over life for 5 seconds each.

(b) Variable speed generator control will limit reaction torque to 130% of rated torque (53,800 ft-lb).

3.4.2 Overspeed Maximum

No degradation with rated torque at 22 RPM for 30 hours total.

3.4.3 Start-Stop

Events to either input speed -- 35,000 over 30 years

High to low plus low to high -- 25,000 while rotating

3.4.4 Reverse Torque

The WTG may utilize the generator to bring the rotor up to speed. In that case the reverse torque will not exceed 50% of rated torque for a total of 600 hours of operation. Parking brake torque may be in either direction when stopped, but will not exceed 80% of rated torque.

3.4.5 Off-Design Operation

The speed increaser may be operated in off-design conditions that consist of either an increase in the effective input torque rating or an increase in the probability of input torques greater than rating. The absolute loads specified in paragraph 3.4.1 will remain unchanged.

Life-duty cycle adjustment shall be computed by translating the upper curve in Figure 1 horizontally such that the curve passes through the new rating point $P_1 (Y_1, X_1)$. Find intersection of translated curve with $Q/Q_{rated} = 1.0$. This fixes point $P_2 (1.0, X_2)$. The adjusted life shall be found as follows:

$$\text{Adjusted Life} = 30 \text{ years} \times \frac{X_2}{.82}$$

The maximum off-design torque rating increase shall be limited to result in a minimum adjusted life of no less than 20 years.

3.5 LIFE

The gearbox shall have a design life of 30 years. Antifriction bearings shall have a B_{10} life of at least 30 years in accordance with AFBMA Standard Sections No. 9 or 11. For the purposes of computing bearing and gear life, the gearbox may be assumed to be operating at rated power and at fractions of rated power for the duration shown in Table 2, during the 30 year life. Gear life shall be determined in accordance with AGMA Aircraft specification. There shall be 3×10^6 torque cycles associated with starting, changing speed, and synchronization with a torque profile of 0%-50%-0% of rated.

3.6 CONFIGURATION

The transmission is to be housed in a casing that is capable of operating under the applicable loads and shall, as a minimum, provide the following functions:

- (a) The case shall serve as a partial oil reservoir for the lubrication system.
- (b) The case shall provide a partial oil cooling (heat rejection) surface.
- (c) The housing shall be of split construction to afford access to internal drive train.
- (d) The housing shall provide environmental protection and oil containment.
- (e) High speed shaft end of housing to provide mounting pads for parking brake and slip rings.
- (f) Bearings of input and output shaft stubs internal to gearbox to be sized to support weight of low speed and high speed drive shaft assemblies (radial loads and thrust loads due to 7° angle of inclination).
- (g) The mounting surface nearest the first stage ring-gear attachment flange on the housing shall be capable of static reaction to all input shaft torques.

3.7 LUBRICATION

A forced feed lubrication system using redundant pumps shall be provided by the gearbox manufacturer. GE shall supply the oil cooler as specified by the gearbox manufacturer. Internal heaters, filters and monitoring sensors shall be supplied by the gearbox manufacturer as required by the environmental and operation considerations. During shutdown and simultaneous loss of electrical power the standby pump shall provide sufficient oil circulation to allow the system to come to a stop without adversely affecting the gears and bearings in a period of five minutes. The gearbox shall be so designed that slow rotation (<1 RPM) with power off under no load will not cause any wear or damage to the drive train. Oil shall return to the reservoir by gravity draining.

3.8 LUBRICATING OIL

The lubricating oil shall be specified by the manufacturer consistent with the operating temperature requirements of paragraph 3.13 and performance requirements of paragraph 3.4.

3.9 CONDUIT PASSAGE

A 6" I.D. center tube shall be designed through the gearbox to allow passage of conduit to rotor. A slip ring assembly 14" O.D. x 48" long shall be mounted on the back face of the third stage housing support structure concentric with the input shaft. Slip ring mounting details will be provided by GE.

3.10 WELDING

Welding shall be in accordance with vendors specification subject to GE review and approval.

3.11 FINISH

3.11.1 Interior Finish

The unmachined surfaces shall be degreased and cleaned prior to painting by the #10 near white blast cleaning method of SSPC-SP10-63T. Paint interior surfaces with an epoxy paint such as Sherwin-Williams POLANE[®] Polyurethane Enamel ASA No. 61 Gray or equal.

3.11.2 Exterior Finish

The case exterior shall be finished as follows:

All unmachined surfaces shall be cleaned prior to painting by the #10 near white blast cleaning method of SSPC-SP10-63T.

Apply one coat of Zinc-rich type primer (Carbo-zinc or equal).

Apply one finish coat per GE Specification 47A380048.

3.12 TURNING GEAR

The gearbox shall be equipped with a "turning gear" to facilitate positioning of the rotor. The turning gear shall drive the gearbox to produce a rotor rate of 0.1 rpm. The gear shall be reversible (i.e. allow cw and ccw rotor rotation). Engagement and disengagement of the turning gear shall be manual.

3.13 OTHER FACTORS

The gearbox shall be designed to withstand the following environmental conditions.

Temperature	-40°C to +50°C (-40°F to +122°F) ambient air (non-operating) -20°C to 40°C (-4°F to 104°F) ambient air (operating)
Humidity Sand/Dust Salt Spray Fungus	exposure equivalent to MIL-STD-210B for exposed or sheltered ground equipment as applicable
Altitude	sea level to 7,000 ft.

SECTION 4.0
QUALITY ASSURANCE PROVISIONS

4.1 MANUFACTURING AND TEST FLOW PLAN

The supplier shall submit a manufacturing and test flow plan showing the basic manufacturing operation, special processes, and tests for General Electric review and establishment of GE inspection points.

4.2 INSPECTION BY GENERAL ELECTRIC

General Electric shall maintain cognizance over the supplier quality system and performance on the material to be furnished. The supplier shall notify General Electric forty-eight (48) hours in advance of the time work, processes, or tests are ready for inspection in accordance with the Manufacturing and Test Flow Plan.

4.3 TEST PLAN

The supplier shall furnish to General Electric a brief plan describing proposed tests of the gearbox. These tests shall include, but are not limited to the following: a four (4) hour no-load run-in test at rated speed, verification of breakaway torque, and no-load loss measurement.

4.4 TEST DATA

The supplier shall record all operating test times and conditions of operation such as speed and load. One copy of this record shall be submitted to General Electric when the gearbox is delivered.

4.5 MATERIAL RECORDS

The supplier shall maintain a file, for General Electric review, all material inspection records (physical and chemical data), radiographic reports, ultrasonic reports, magnetic particle reports and similar test data related to the gearbox supplied to General Electric.

SECTION 5.0
PREPARATION FOR SHIPMENT (Later)

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A	6	Table 3-1	05/25/83	<i>WCT</i> <i>AN-1</i>

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SECTION 1

1.0 SCOPE

This specification defines performance, design and test requirements for a variable speed generator subsystem for wind turbine application. Subsystem components defined are a wound rotor machine, a cycloconverter, the cycloconverter control, isolation transformers, and accessories.

SECTION 2

2.0 APPLICABLE DOCUMENTS

The following documents of the latest issue or as noted below form a part of this specification to the extent specified herein. In the event of conflict between this specification and the documents referenced herein, the contents of this specification shall be considered a superseding document.

2.1 GENERAL ELECTRIC DRAWINGS AND SPECIFICATIONS

47E387080	System One-Line Diagram
(TBD)	Generator and Lube Mechanical Interface
(TBD)	Cycloconverter Mechanical Interface
(TBD)	Isolation Transformer Mechanical Interface

2.2 OTHER STANDARDS

CSA (Canadian Standards Association)
(TBD)

ANSI (American National Standards Institute)
(TBD)

NEMA (National Electrical Manufacturers Association)
(TBD)

IEEE (Institute of Electrical and Electronics Engineers)

STD 472 Transient Voltage Protection

STD 519 Guide For Harmonic Control and Reactive Compensation Of Static
Power Converters

MIL-STANDARDS

MIL-STD-461 Electromagnetic Emission and Susceptibility Requirements For The
Control Of Electromagnetic Interference

MIL-STD-462 Test Methods For Electromagnetic Emission And Susceptibility

FEDERAL

FS-595A Finish Colors

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SECTION 3

3.0 REQUIREMENTS

3.1 SUBSYSTEM DEFINITION

3.1.1 GENERAL DESCRIPTION

The variable speed generator subsystem consists of:

- a) Wound rotor generator
- b) Cycloconverter
- c) Cycloconverter control
- d) Isolation transformer
- e) Accessories

Interconnection and installation of the subsystem will be provided by the purchaser. Subsystem capabilities shall be to:

- f) Motor, singly excited, from 0 to 0.25 per unit synchronous speed
- g) Synchronize for doubly excited operation
- h) Regulate system reactive power flow while generating with an output var regulation loop or a terminal voltage regulation loop
- i) Regulate air gap torque while generating from 0.80 to 1.20 per unit synchronous speed
- j) Provide sequencing control and communication with purchaser equipment

3.1.2 SUBSYSTEM CONFIGURATION

The subsystem shall be arranged as shown on Drawing 47E387080, System One-Line Diagram. Physical location of subsystem elements shall be as shown in Figure 3-1. Interconnection shall be as shown in Figure 3-2.

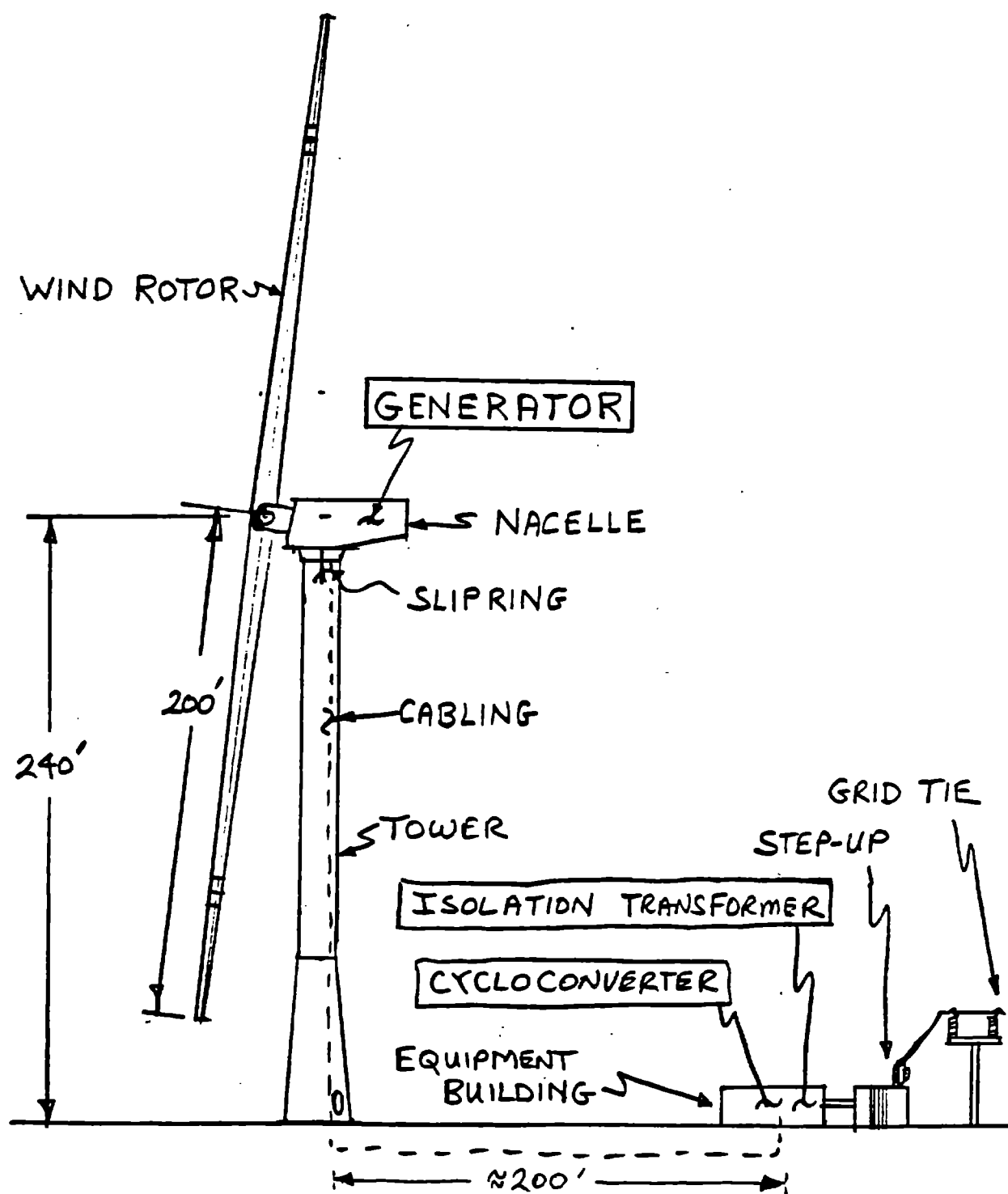


FIGURE 3 - 1

PHYSICAL LOCATION OF SUBSYSTEM

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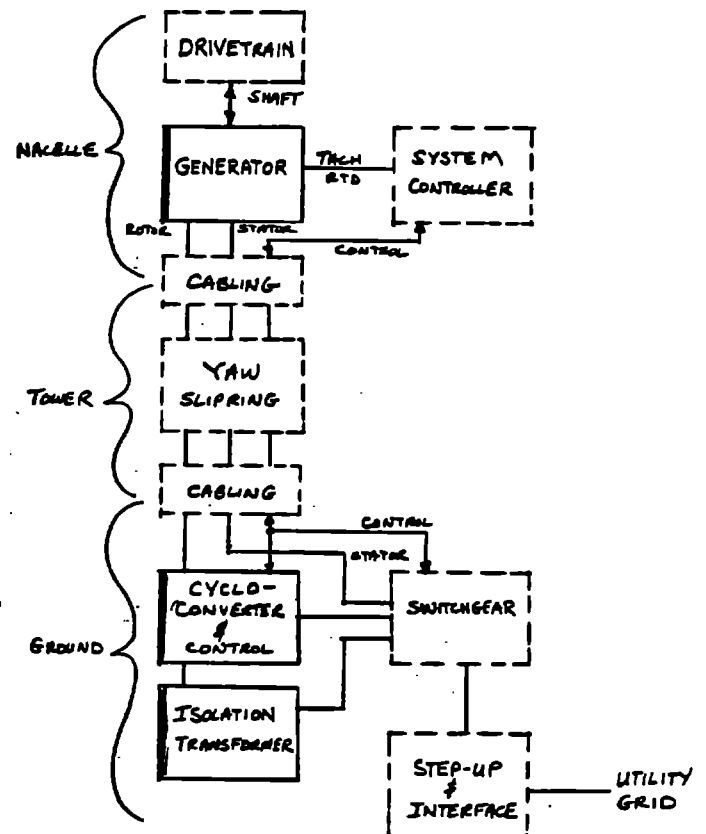
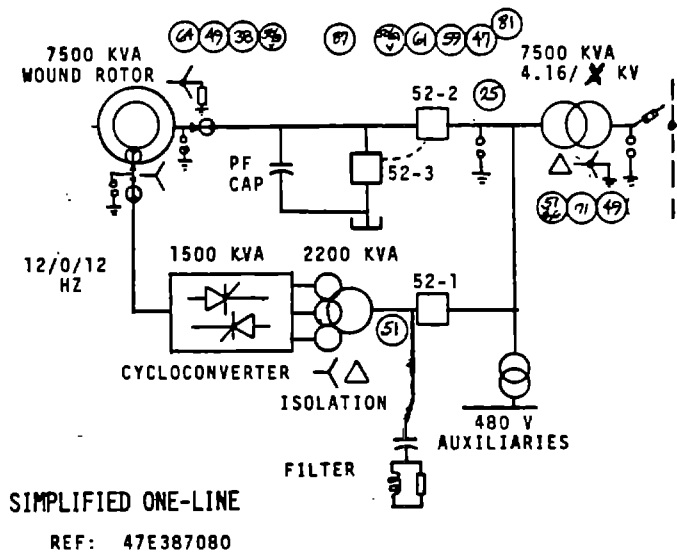


FIGURE 3 - 2

INTERCONNECTION BLOCK DIAGRAM

3.1.3 INTERFACE DEFINITION

3.1.3.1 Generator Mechanical Interfaces

The generator mechanical interfaces shall be per Table 3-1 and TBD Installation Drawing

TABLE 3-1
Generator Mechanical Interfaces

<u>Item</u>		
1	Interface Drawing	(TBD) Generator and Lube Mechanical Interface Drawing
2	Generator Installation	(TBD) Geometry Outline, TBD (Installation Drawing)
3	Shaft Coupling	Installation by TBD
4	Shaft Loads	Torque 38,500 \pm 3,850 Rating Ft-Lb Vertical 2000 \pm 400 lb Horizontal 0 \pm 200 lb Moment 1000 \pm 200 ft-lb
5	Turbine Inertia	350,000 lb ft ² @ 1200 RPM
6	Air Ducting	Per TBD (Installation Drawing)
7	Flood Lube System	Per TBD (Installation Drawing)
8	Mounting	I-Beam frame, supplied with generator, supports machine. Frame to be shimmed/grouted to bedplate and bolted in place.
9	Connections	Connection boxes suitable for 250 lb man to stand on. Conduit or cable duct may introduce up to 200 lb force in any direction.

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3.1.3.2 Generator Electrical Interfaces

The generator electrical interfaces shall be per Table 3-2 and TBD Installation Drawing.

TABLE 3-2

Generator Electrical Interfaces

<u>Item</u>		
1	Stator	Six (6) leads out, compression connectors with lugs Purchaser connection via two (2) 350 MCM, 5 KV cable per phase.
2	Rotor	Three (3) leads out, compression connectors with lugs (TBD) connection box Purchaser connection via two (2) 350 MCM, 5 KV cable per phase.
3	RTD's	Three (3) lead type to terminal strip. Six (6) RTD connections required, others with leads coiled and marked in box. Purchaser connection via wire clamp suitable for #16 AWG or captive screw terminal strip.
4	Heaters	Four (4) lead connection to separate terminal strip. Purchaser connection via wire clamp suitable for #10 AWG or captive screw terminal strip.
5	Tachometers	Four (4) leads type to separate terminal strip. (Power, Power common, signal, signal return.) Purchaser connection via wire clamp suitable for #16 AWG. Tachometer pickups shall have locking plug connections.
6	Ground	Frame grounding location for purchaser lug connection.
7	Switches	Two (2) lead type to terminal strip. Purchaser connection via wire clamp suitable for #16 AWG or captive screw terminal strip.
8	Lube System	Power per item 4 above Sensors per item 7 above Lubrication system controls and sensors C-1 System on/off control S-1 Outlet pressure switch - low S-2 Sump level switch - low S-3 Fluid temperature switch - high S-4 Fluid temperature switch - low S-5 Filter differential pressure switch

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3.1.3.3 Cycloconverter Mechanical Interfaces

Interfaces shall be per Table 3-3, and TBD Installation Drawing.

TABLE 3-3

Cycloconverter Mechanical Interfaces

<u>Item</u>		
1	Installation Outline	TBD Electrical Equipment Building TBD Installation Drawing
2	Mounting	Leveled on concrete slab with anchor bolt/stud holddown.
3	Connections	Cable/bus duct interface may impose 200 lb load in any direction. Power circuit connections via overhead duct. Control and signal leads shall be connected in a separate interface terminal area. Interconnection will be via overhead ducting.

3.1.3.4 Cycloconverter Electrical Interfaces

Interfaces shall be per Table 3-4, and TBD Installation Drawing.

TABLE 3-4

Cycloconverter Electrical Interfaces

<u>Item</u>		
<u>Power</u>		
P-1	Machine Side	Three (3) dual bus/lug connections Purchaser connection using two (2) 350 MCM, 5 KV Cables per Phase
P-2	Bus Side	Nine (9) bus/lug connections. Purchaser connection to isolation transformer TBD.
P-3	Auxiliary	480 V, 4-wire, 30 Amp Purchaser connection via wire clamp suitable for #6 AWG or separate terminal strips.
P-4	Ground	Bus/lug connection to ground bus.
<u>Control - General</u>		
C-1	Discrete	Discrete signals to and from the wind turbine controller shall be two wire 120 VAC, maintained signal. The active (sending) end shall switch the source and the sensing end shall be high impedance and provided with (TBD) shunt resistance to avoid false indication due to switching device leakage current. Current range is 3A maximum, 20 ma minimum.
C-2	Analog	Analog signals to and from the wind turbine controller shall be twisted pairs, shielded 4-20 ma current loop. The active (sending) end shall be able to drive loop impedances from 0 to 1000 ohms. Signal receiver input impedance shall be 500 ohms approximately.
C-3	Tachometer	Tachometer pulse signals shall be TBD, to suit system arrangement
C-4	Potential Transformers	PT secondary connections shall be two wire suitable for 300 VAC transient duty.
C-5	Current Transformers	CT secondary connections shall be two wire suitable for 20 amp transient duty. Shorting bars shall be provided on the interface terminal strip. CTs only for converter use.

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TABLE 3-4 (cont'd)

Cycloconverter Electrical Interfaces

- C-6 Power Control Switchgear control signals shall be 48 VDC relay coil circuits. Purchaser will provide external 48 VDC. Dry contact switching suitable for 5 amp make and break shall be provided, with purchaser's control circuit providing circuit interruption.
- C-7 Connections All purchaser control connections shall be via wire clamp suitable for #12 AWG, or captive screw terminal strips.

Signals

- | | | |
|--------------|--------------------------|-----------------------------------|
| S-1 | "Converter Ready" | Per C-1, converter control source |
| S-2 | "Turbine Ready" | Per C-1, turbine control source |
| S-3 | "Start/Motor" | Per C-1, turbine control source |
| S-4 | "Synchronize/Generate" | Per C-1, turbine control source |
| S-5 | "Torque/Speed Reference" | Per C-2, turbine control source |
| S-6 | "VAR/Volt Reference" | Per C-2, turbine control source |
| S-7 | "Lockout Trip" | Per C-6 |
| S-8 | "Stator Tie Trip" | Per C-6 |
| S-9 | "Stator Short Trip" | Per C-6 |
| S-10 | "Stator Tie Close" | Per C-6 |
| S-11 | "Stator Short Close" | Per C-6 |
| S-12 | "Stator Tie Position" | Per C-1, "a" contact |
| S-13 | "Stator Short Position" | Per C-1, "a" contact |
| S-14 | "Stator Voltage" | Per C-4, 3 Phase |
| S-15 | "Bus Voltage" | Per C-4, 3 Phase |
| S-16 | "Stator Current" | Per C-5, 3 Phase |
| S-17 | "Bus Current" | Per C-5, 3 Phase |
| S-18 to S-30 | | Spares |

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3.1.3.5 Isolation Transformer Mechanical Interfaces

Mechanical interfaces for the isolation transformer shall be similar to the companion interfaces for the cycloconverter per paragraph 3.1.3.3 and the TBD Installation Drawing.

3.1.3.6 Isolation Transformer Electrical Interfaces

Electrical interfaces for the isolation transformer shall be similar to the companion interfaces for the cycloconverter per paragraph 3.1.3.4 and TBD Installation Drawing.

3.1.4 OPERATIONAL DESCRIPTION

3.1.4.1 Duty Cycle Description

The annual design wind cumulative probability and resultant output power cumulative probability are shown in Figure 3-3. Annual start-stop cycles are 1200; approximately three (3) per day.

A typical operating cycle consists of:

- a) Motor the generator to 0.25 per unit synchronous speed - one (1) minute
- b) Shaft driven by turbine to 0.8 per unit synchronous speed - two (2) minutes
- c) Synchronize at 0.8 per unit - 0.1 minutes (synchronize ability from 0.8 to 1.2 pu)
- d) Operate at 0.9 - 0.95 per unit synchronous speed at air gap torques from 0 to 1.0 per unit, externally referenced - 60 minutes
- e) Accelerate under wind turbine system control to 1.15 per unit synchronous speed - 0.5 minute (external reference reduces air gap torque to provide acceleration)
- f) Operate at 1.10 - 1.20 per unit synchronous speed at air gap torques from 0 to 1.10 per unit, externally referenced - 60 minutes
- g) Decelerate under wind turbine system control to 0.95 per unit synchronous speed - 0.5 minute (external reference increases air gap torque to provide deceleration)
- h) Repeat d) through g) above one to four times
- i) Hold air gap torque at 1.0 per unit while decelerating to 0.8 per unit synchronous speed, externally referenced - 0.5 minute
- j) Reduce shaft torque to zero - 0.2 minute
- k) Externally reduce speed by turbine control to 0 per unit - two (2) minutes

1 per unit synchronous speed = 1200 rpm

1 per unit air gap torque = 38,500 ft-lb
(based on 6300 KVA, 1.0 pf, 0.96 efficiency at 1200 rpm)

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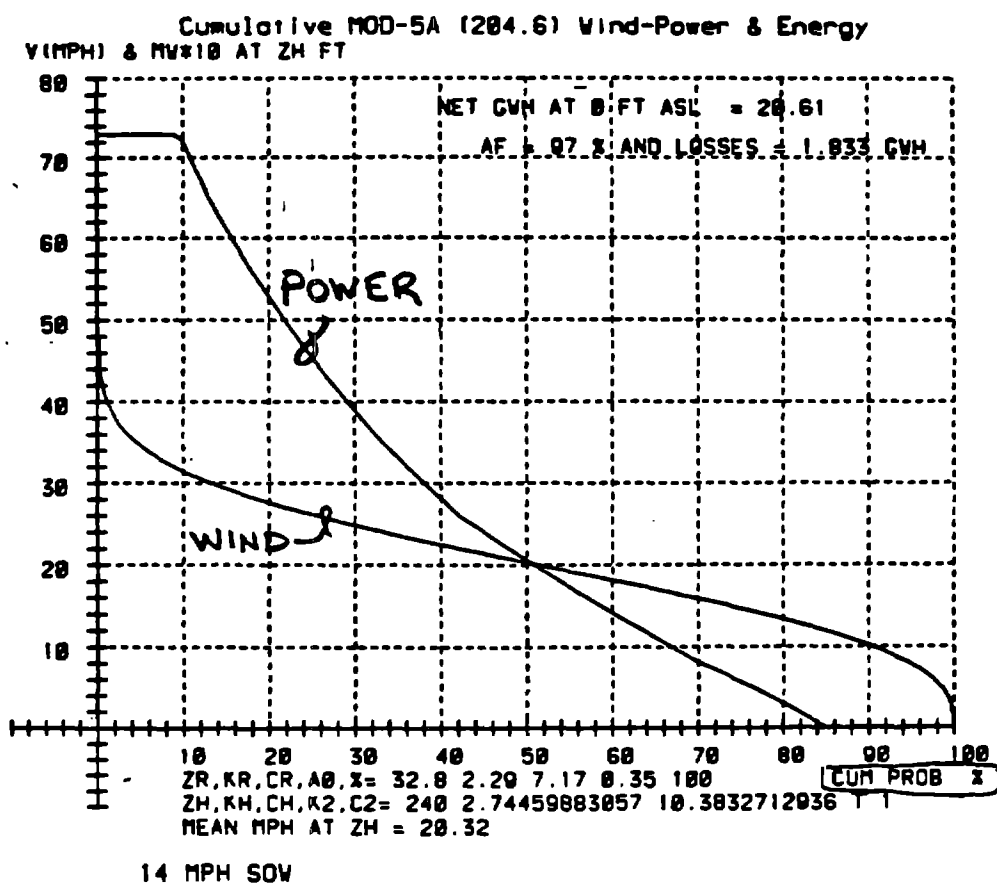


TABLE 3-3

WIND AND POWER DISTRIBUTION

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3.1.4.2 Operational Speed - Power Description

The subsystem shall be capable of operation within the speed-power envelope map shown in Figure 3-4. Constant air gap torque operation is shown between 0.8 and 1.2 pu synchronous speed. Motoring duty operation from 0 to 0.25 pu synchronous speed shall be constant rotor current.

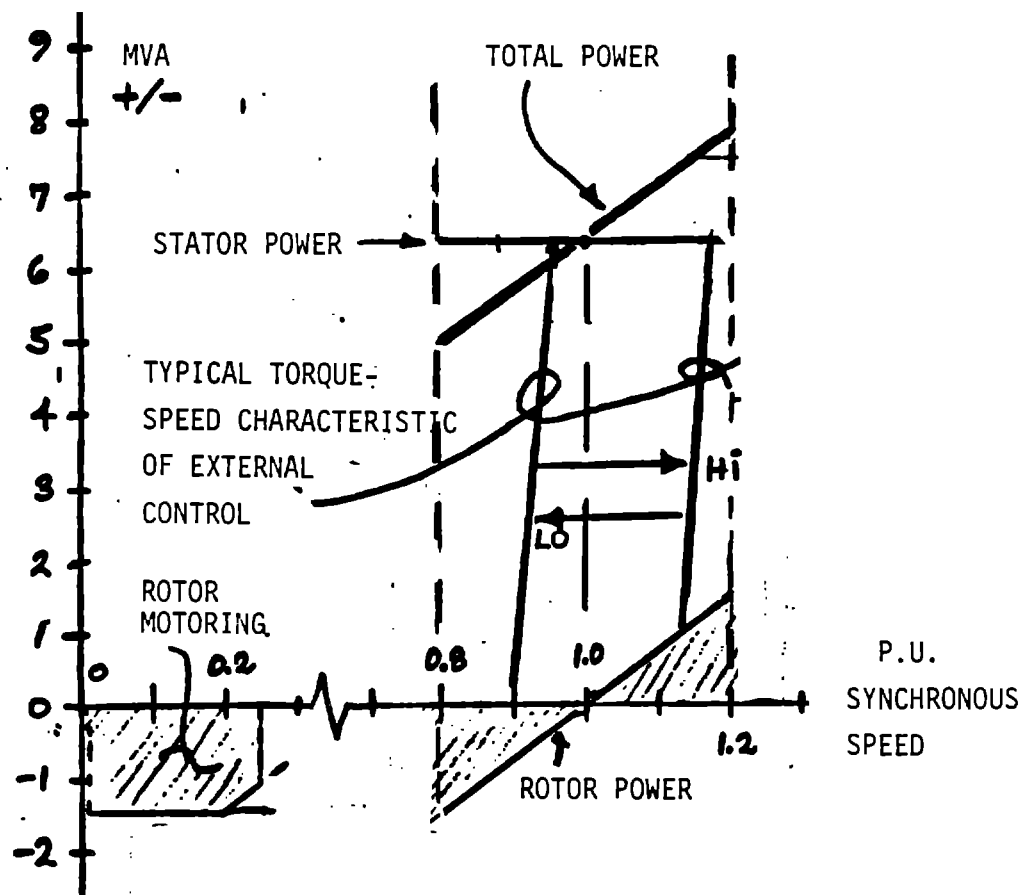


FIGURE 3-4
SPEED-POWER ENVELOPE

3.2 CHARACTERISTICS

3.2.1 GENERATOR

3.2.1.1 Generator Characteristics

The generator shall have the characteristics shown in Table 3-5. Standard ratings shall be based on appropriate CSA, ANSI, and NEMA standards. The supplier shall identify the standards utilized.

TABLE 3 - 5

GENERATOR CHARACTERISTICS

<u>Item</u>	
1	Type Wound rotor construction, doubly fed
2	Rating 6300 KVA stator 1500 KVA rotor (1500/0/1500) 7500 KVA total 38,500 ft-lb air gap torque
3	Frame Open, drip proof
4	Poles, Speed 6 pole - 1200 rpm synchronous speed, 960/1200/1440 operating range Rotation CCW looking at drive end
5	Insulation Class F with Class F rise at rating (105°C rise over 40°C ambient temperature)
6	Voltage Stator 4160 Volt L-L, 60 Hz AC, 3 Phase Rotor winding coordinated with cycloconverter, 12/0/12 Hz AC, 3 Phase, approximately 800/0/800 Volt L-L rms, approximately
7	Connection Per paragraph 3.1.3.2 Stator - Wye, 6 leads out for external neutral connection Rotor - Wye, 3 leads out on slip rings - brushes, neutral insulated
8	Grounding Stator neutral will be high resistance grounded by purchaser to limit phase to ground fault current to less than 0.2 pu. Shaft to frame grounding brushes shall be installed at bearings.

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TABLE 3 - 5 (cont'd)

GENERATOR CHARACTERISTICS

<u>Item</u>	
9	<p>Cooling</p> <p>Self ventilated via shaft mounted fans. Provision made for purchaser installed intake and exhaust ducting. Purchaser will provide external fan for low speed motoring duty cooling, if required.</p>
10	<p>Mounting</p> <p>Per paragraph 3.1.3.1. Up to 7° inclination from horizontal with drive end high.</p>
11	<p>Bearings</p> <p>Double bearings, self-lubricated, journal type. Drive end bearing shall have thrust capability sufficient to restrain 1.2 times rotor weight force component due to 7° inclination, and radial capability per paragraph 3.1.3.1. The generator bearings shall be provided with a means of transient self-lubrication to avoid damage on coast down from 1440 rpm at 10 rpm/second without flood lubrication.</p>
12	<p>Flood Lube</p> <p>Purchaser installed flood lubrication system. Capped inlet and outlet piping and appropriate bearing openings shall be provided. A separately mounted flood lubrication system package shall be provided for continuous supply of bearing lubrication fluid. The skid or tank mounted unit shall consist of a reservoir heater, filter, pump, pump motor, motor starter, sensors, and electrical and hydraulic interconnections. Power, control, and sensing devices shall be per paragraph 3.1.3.2.</p>
13	<p>Operation</p> <p>Per paragraph 3.1.4 duty cycle. Basic operation modes are with constant rotor current from 0 to 0.25 pu synchronous speed, and with constant air gap torque from 0.8 to 1.2 pu synchronous speed.</p>
14	<p>Overspeed</p> <p>1700 rpm mechanical overspeed design (118% of 1.2 pu synchronous speed)</p>
15	<p>Losses</p> <p>No load at 1.0 pu synchronous speed, 100 kW maximum losses. Rated output at 1.2 pu synchronous speed, 300 kW maximum losses. Computed losses shall be specified for 0, .25, .50, .75, 1.0 pu rating air gap torque conditions at 0.8, 1.0, and 1.2 pu synchronous speed.</p>
16	<p>Overload</p> <p>Shafting capable to withstand 2.5 pu rated air gap torque conditions for 100 times over life time.</p>

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- 17 Impedances The manufacturer's standard design practices shall be used. Rotor impedance shall be coordinated with the cycloconverter design.
- 18 Maintenance Design shall be suitable for a six (6) month or more periodic inspection and maintenance interval. Brushes shall have twelve (12) month minimum mechanical design life. Bearings shall be replaceable without rotor removal.
- 19 Life Expected design life, with periodic maintenance shall be 30 years.
- 20 Materials Construction materials shall be inherently corrosion resistant or protected from corrosion due to exposure to airborne moisture and salt in cooling air per paragraph 3.2.1.3.
- 21 Altitude Per paragraph 3.2.1.3
- 22 Weight, Size As identified on Mechanical Interface Drawing (TBD).
- 23 Turbine Inertia Motoring duty shall be based on the turbine inertia defined in paragraph 3.1.3.1.

Accessories

- A-1 Connection Boxes Oversize connection boxes shall be provided, mounted as shown on Mechanical Interface Drawing (TBD) to house both rotor and stator circuit surge arrestors and surge capacitors. Separate connection boxes shall be provided for instrumentation and heater connections
- A-2 Surge Protection (Option) Stator and rotor circuits shall be provided with 5.1 KV lightning arrestors and 0.5 MFD wave shaping capacitors connected from each phase to the machine frame, mounted and connected in terminal boxes.
- A-3 Winding RTDS Each phase of the stator windings shall have two (2) 10 ohm copper 3 lead Resistance Temperature Detectors installed and wired to the instrument connection box.
- A-4 Bearing RTDS Each bearing shall have one (1) 10 ohm copper 3 lead Resistance Temperature Detector installed and wired to the instrument connection box.

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TABLE 3 - 5 (cont'd)

GENERATOR CHARACTERISTICS

Item

- | | | |
|-----|--------------------|--|
| A-5 | Tachometer Pickups | The rotor shaft shall be supplied with a toothed wheel having 120 (approximately) teeth. Two pulse generator pickups shall be mounted adjacent to the wheel and wired to the instrument connection box. One pickup is for cycloconverter control use and the other is for purchaser use. The purchaser use pickup shall supply an approximately 5 volt square wave output with purchaser provided excitation. The cycloconverter control pickup shall provide a signal level suitable for transmission over 600 feet of coaxial or twisted shielded pair wiring. |
| A-6 | Space Heater | An anti-condensation heater, suitable for continuous energization, shall be mounted and wired to the instrumentation terminal box. 208 VAC, 4 wire, 3 Phase, 60 Hz power at 3 kW maximum will be provided by purchaser for balanced load heater operation. |
| A-7 | Ground Pad | An unfinished, flat, frame connection location with two (2) tapped or clearance holes with back access shall be provided for attaching a ground connection with 1/2-13 hardware. This shall be located near a lower side corner of the frame. |
| A-8 | Vibration Switches | Each bearing shall have a vibration sensor (switch type) of the supplier's recommended type, mounted and wired to the instrumentation connection box. |

3.2.1.2 Generator Parameters

The supplier shall provide the purchaser with the data shown in Table 3-6 within ten (10) weeks of receipt of order.

TABLE 3 - 6

GENERATOR PARAMETERS

Item

- 1 Weight (lb) and Center of Gravity location
- 2 Rotor inertia (lb-ft²) and shaft sketch
- 3 Breakaway torque (lb-ft)
- 4 Cooling air requirements (SCFM, psi drop, temperature rise)
- 5 Bearing lube requirements (GPM, viscosity for flood lube)
- 6 Losses calculation per Table 3-5, item 15
- 7 Magnetizing reactance (Xm) (per unit value based on 4160 volts, 7500 KVA)
- 8 Stator reactance (X1) pu
- 9 Stator resistance (R1) pu
- 10 Rotor reactance (X2) pu referred to stator
- 11 Rotor resistance (R2) pu referred to stator
- 12 Air gap saturation characteristics (curve)
- 13 Outline drawing showing installation handling and shipping package details and access requirements for installation and maintenance
- 14 Connection diagram; power and instrumentation elementary diagrams
- 15 Summary parts list and recommended spare parts list
- 16 Draft instruction book (final with delivery) including maintenance requirements
- 17 Auxiliary power requirements

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3.2.1.3 Generator Environmental Conditions

The generator will be housed within an unheated, insulated metal enclosure at the top of a 240 foot tower. Ambient temperatures during operation will range from -20°C to +40°C. Survival (non-operating) ambient temperatures will range from -40°C to +50°C. Relative humidity will be 10% to 90%, non-condensing.

Ratings apply for altitudes from sea level to 3300 ft. Application may be at up to 7000 ft with higher ambient temperatures in which case appropriate derating will be used for cooling and insulation properties.

Cooling air will be mechanically filtered by purchaser to remove most airborne moisture, salt, and particulates. For corrosion analysis assume 0.005 PPM maximum salt content in intake air after filtration for sea coast installation.

Vibration while operating may be up to ± 0.25 g in any direction at frequencies less than 5 Hz.

3.2.2 CYCLOCONVERTER

3.2.2.1 Characteristics

The cycloconverter shall have the characteristics shown in Table 3-7. Standard ratings shall be based on appropriate CSA, ANSI, and NEMA standards. The supplier shall identify the standards utilized.

TABLE 3-7
CYCLOCONVERTER CHARACTERISTICS

<u>Item</u>		
1	Type	Thyristor, 3 Phase, 6 pulse per phase, reversing
2	Rating	1500 KVA
3	Machine Connection	Coordinated with generator rotor characteristics per Table 3-5, item 6
4	Line Connection	Through isolation transformer to 4160 volt L-L, 60 Hz, 3 Phase
5	Enclosure	Indoor NEMA 1 type with front door access to all electronic components, and rear panel access to connections.
6	Frequency	Line connection 60 Hz. Machine connection with real power capability proportional to frequency for 12/0/12 Hz operation.
7	Harmonics	Converter control and connection shall minimize current harmonics on the 60 Hz system, consistent with economic control and theoretical 6 pulse converter harmonic production.
8	Harmonic Filters	Purchaser will provide 60 Hz system filtering consistent with IEEE Standard 519.
9	Reactive Power	Converter reactive power duty will be minimized by use of 60 Hz system filter and power factor correction capacitance. System operation will be at 0.98 to 1.0 pf.
10	Overvoltage Protection (option)	A machine side thyristor controlled resistive shunt shall be evaluated to provide transient overvoltage protection to the power circuitry and to extend operating frequency range.
11	Cooling	A dual fan shall be provided for circulation of ambient air. Either fan shall be capable of cooling from rated conditions. Fan control shall be provided for alternating operation on startup and shift to other fan on loss of air flow during operation.
12	Fault Protection	Power modules shall be fused to prevent module permanent faults from propagating damage.

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TABLE 3-7 (cont'd)
CYCLOCONVERTER CHARACTERISTICS

<u>Item</u>	
13	Control Per paragraph 3.2.2.4. Basic control mode is independent control of machine air gap torque by stator power regulation and control of 60 Hz bus reactive power or voltage.
14	Losses No load, with control and fan loads, 10 kW maximum. Rated conditions, 25 kW maximum
15	Maintenance Design shall be suitable for a six (6) month or more periodic inspection and maintenance interval. Control and power elements shall be of modular construction and replaceable from the front of the unit.
16	Diagnostics Light indicators and local logic devices shall be provided to aid in rapid fault diagnosis to maximize availability.
17	Reliability The allocated reliability goals for the converter and control assembly are: Mean Time Between Failures Requiring Maintenance - 9,000 hours Mean Time to Repair - 2 hours (with spare parts on hand)
18	Life Expected design life, with periodic maintenance shall be 30 years.
19	Materials Construction materials shall be inherently corrosion resistant or protected from corrosion due to exposure to airborne moisture and salt in cooling air per paragraph 3.2.2.3. Circuit boards should be conformal coated where possible for general contamination protection.
20	Altitude Per paragraph 3.2.2.3
21	Space Heater An anti-condensation heater, suitable for continuous energization shall be mounted and wired in the bottom of each equipment section. 208 VAC, 4 wire, 3 phase, 60 Hz power at 2 kW maximum will be provided by purchaser for balanced load heater operation.
22	Grounding A ground bus shall be run through all equipment sections and have a readily accessible purchaser connection.
23	Bus Work Bus bar shall be of manufacturers standard construction. Connections shall be immune to the effects of zero to full load cycling.

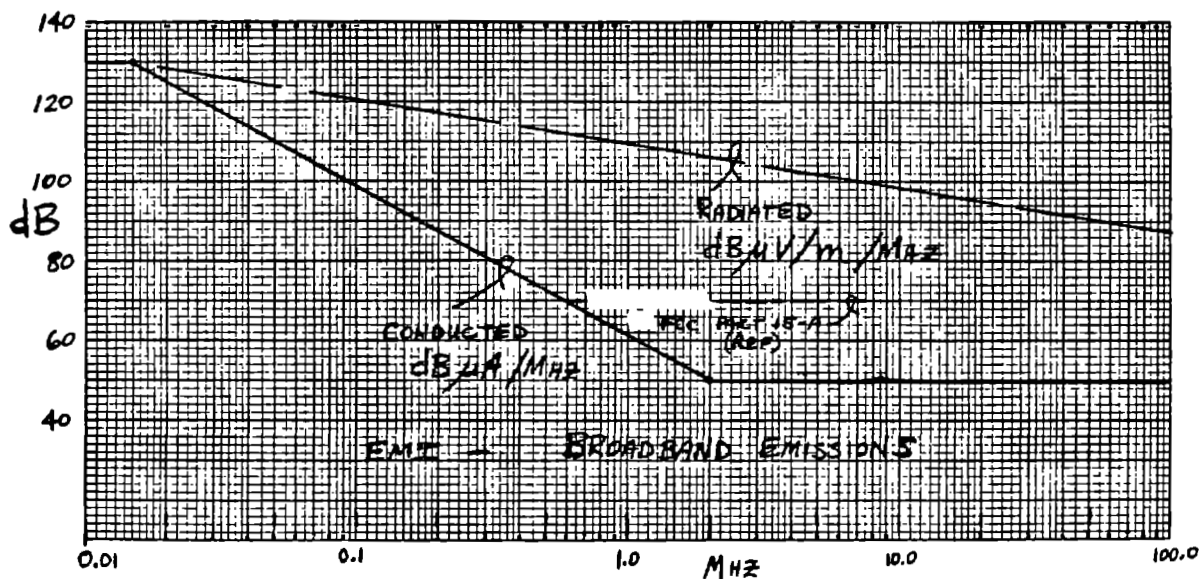
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TABLE 3-7 (cont'd)
CYCLOCONVERTER CHARACTERISTICS

Item	
24 EMI	<p>The cycloconverter and its controller shall not produce conducted or radiated signals that interfere with commercial electromagnetic devices. The converter and its controller shall not malfunction where a portable communication device with up to 5 watt transmitter power is operated within 10 feet with cabinet doors closed.</p> <p>IEEE STD 472 surge requirements shall be provided on external connection points. Measurement of conducted and radiated electromagnetic emissions using procedures of MIL-STD-462 may be performed by the purchaser. The supplier shall provide representative data on his equipment. Measured data shall be less than the values shown in Figure 3-5, from MIL-STD-461.</p>

3.2.2.2 Cycloconverter Parameters

The supplier shall provide the purchaser with the data shown in Table 3-8 within ten (10) weeks of receipt of order.



EMI ENVELOPE

FIGURE 3-5

TABLE 3-8

Cycloconverter Parameters

Item

- 1 Weight (lb)
- 2 Outline drawing showing installation and handling and shipping package details
- 3 Elementary and connection, power, instrumentation, control diagrams.
- 4 Cooling air requirements (SCFM, psi drop, temperature rise)
- 5 Losses calculation per Table 3-7, Item 14
- 6 Harmonic current calculations for rated, and near synchronous conditions through the 25th harmonic with typical impedance.
- 7 Summary parts list and recommended spare parts list
- 8 Draft instruction books (final with delivery) including maintenance requirements
- 9 Auxiliary power requirements

3.2.2.3 Cycloconverter Environmental Conditions

The cycloconverter, and the isolation transformer connecting to the 4160 Volt 60 Hz bus will be housed within a building at grade level. Ambient temperatures during generation will range from 0°C to +40°C. Survival (non-operating) ambient temperatures will range from -40°C to +50°C. 10% to 90% humidity, non-condensing.

Ratings apply for altitudes from sea level to 3300 ft. Applications may be at up to 7000 ft with higher ambient temperatures in which case appropriate derating will be used for cooling and insulation properties. Cooling air will be mechanically filtered by purchaser to remove most airborne moisture, salt, and particulates. For corrosion analysis assume 0.005 PPM maximum salt content in intake air after filtration for sea coast installation. Cooling air will have a dew point sufficiently below ambient temperature to avoid condensation.

3.2.2.4 Cycloconverter Control

3.2.2.4.1 General

The cycloconverter control shall use proven components and assemblies where available. Bandwidth of the converter, generator, and control shall be as broad as practical with a goal of 80 radians/sec or higher equivalent first order lag (-3 dB, -45°).

Slue rate of the control response to changes in analog reference signals shall be limited by the control to 50%/second full scale in response to a step input.

3.2.2.4.2 Control Modes

Basic operating modes of the control are:

- Initialization
- Motoring, singly excited machine
- Synchronization
- Torque regulation
- Reactive power regulation
- Shutdown
- Fault monitoring

Signals in the following paragraphs are shown on Paragraph 3.1.3.4

3.2.2.4.2.1 Initialization. The initialization mode occurs on converter control power-up. All outputs shall power-up to an off-state. The converter firing control shall be configured to a non-conduction state. Control power will be applied before 4160 volt line power is connected.

Next, the control shall check for faults appropriate to a non-operating state. If no faults exist, then send a "converter ready" to the turbine control, and wait for further commands. If a fault exists, wait for repair.

3.2.2.4.2.2 Motoring, Singly Excited. On receipt of a "start/motor" command,

- a) check for "Turbine Ready"
- b) turn on cooling fan and check air flow
- c) send "Stator Tie Trip" and check "Stator Tie Position" is open
- d) send "Stator Short Trip" and check "Stator Short Position" is open
- e) send "Stator Short Close" and check "Stator Short Position" is closed
- f) using the "Torque/Speed" analog reference, with overriding current limit, rotor volts/hertz limit, and frequency limit, control converter operation regulating speed to cause the generator to accelerate or decelerate from 0 to approximately 300 rpm
- g) at the upper end of the permissible speed range, wait for removal of the "Start/Motor Command"
- h) on "Start/Motor" command removal, slue rotor current to zero, independent of the "Torque/Speed" reference, then
- i) send "Stator Short Open" command and check "Stator Short Position" is open
- j) hold converter in a non-conducting mode and wait for "Synchronize/Generate" command. The turbine control will accelerate generator shaft speed to the 960 to 1440 rpm generating range.

NOTE: The turbine control will utilize a "Stator Short Position" signal and a turbine speed signal to verify converter control response.

3.2.2.4.2.3 Synchronization. On receipt of a "sync/generate" signal,

- a) Check for generator speed between 960 and 1440 rpm. If outside this range, wait until range is reached.
- b) Utilizing "Stator Voltage" and "Bus Voltage" instrument transformer secondaries, control converter firing to cause induced stator voltage to match bus voltage in amplitude, frequency, phase, and phase sequence.
- c) When voltages are matched, send "Stator Tie Close" and check "Stator Tie Position" is closed. (Note: Purchaser will provide synchronize check relay function in close circuit.)
- d) After the stator tie is closed, operate simultaneously in both torque regulation and reactive power regulation modes.

3.2.2.4.2.4 Torque Regulation

- a) Using the "Torque/speed" analog reference, regulate air gap torque as indicated by stator real power. Develop stator power feedback from "Stator Voltage" and "Stator Current" instrument transformer secondaries.
- b) If reference torque transiently exceeds system rated capability, automatically limit torque to 110% of rated system capability.
- c) Wait for removal of "sync/generate" command.

Torque regulation shall achieve $\pm 1\%$ of rated air gap torque within one (1) second after a 20% step change in reference with shaft slue rates of up to 0.05 pu/second relative to synchronous speed. Range is -20% to +120% of rated torque.

3.2.2.4.2.5 Reactive Power Regulation

- a) Using the "Var/Volt" analog reference, regulate 4160 volt bus reactive power. Develop reactive power feedback from "Bus Voltage and "Bus Current" instrument transformer secondaries.

3.2.2.4.2.5 Reactive Power Regulation (cont'd)

- b) If the reference Var value exceeds system capability due to rotor circuit KVA or stability limits, automatically limit Var regulation as necessary to maintain torque regulation. Simultaneous regulation is required, but torque regulation has higher priority when limiting conditions are reached.

- c) Wait for removal of "sync/generate" command.

Reactive power regulation shall achieve $\pm 1\%$ of system KVA rating within one (1) second after a 20% step change in reference with shaft slue rates of up to 0.05 pu/second relative to synchronous speed. Voltage control shall be a switch selectable optional regulation mode, using "Bus Voltage" as feedback. Ranges are $\pm 10\%$ of 7500 KVA or 4160 Volts, depending on mode.

3.2.2.4.2.6 Shutdown. Shutdown is initially the same as the generating condition. The "Torque/Speed" reference will be ramped up to maximum value at 5%/second and shaft speed will be reduced by the turbine control.

- a) When generator speed reaches approximately 980 RPM, the turbine control will ramp the "Torque/Speed" reference to zero at 5%/second while externally regulating turbine speed, then
- b) the turbine control will remove the "Sync/Generate" command.
- c) On "Sync/Generate" command removal, the converter control shall automatically regulate stator watts and stator Vars to zero, regardless of analog reference values.
- d) When stator watts and stator Vars are below 5% of rating, the converter control shall send a "Stator Tie Open" command and check that "Stator Tie Position" is open.

3.2.2.4.2.6 Shutdown. (cont'd)

- e) Bring converter to a non-conducting state .
- f) The turbine control will bring the generator speed to zero.
- g) When speed is below 60 rpm and when temperature is acceptable or after a time delay, turn off cooling fan
- h) Wait for a "Start/Motor" command

3.2.2.4.2.7 Fault Monitoring. The converter control shall monitor converter and turbine operation for at least the following faults:

- a) overpower - stator, motoring or generating
- b) overpower - rotor, motoring or generating
- c) converter overcurrent
- d) bridge fault
- e) control malfunction
- f) control power loss
- g) cooling air loss
- h) phase unbalance
- i) overspeed beyond 1500 RPM
- j) turbine control ready signal
- k) Stator over/under voltage
- l) uncommanded stator tie breaker trip

For items i) and j), the converter control shall automatically ramp the torque reference used for torque regulation to maximum value until generator speed goes below 960 RPM, then continue as if in the shutdown mode following a "Sync/Generate" command removal.

For item g), the converter control shall turn on the second cooling fan and if cooling air flow recovers, continue operation.

3.2.2.4.2.7 Fault Monitoring. (cont'd) For all faults but g), the converter control shall remove the "Converter Ready" signal to the turbine control which will cause shutdown initiation. If a cooling air fault g) is not cleared by operation of the second fan, then remove the "Converter Ready" signal.

For permanent faults requiring maintenance action, the converter control shall open the stator tie circuit breaker via the "Lockout" relay.

3.2.3 ISOLATION TRANSFORMER

3.2.3.1 Characteristics

The isolation transformer shall have the characteristics shown in Table 3-9. Standard ratings shall be based on appropriate CSA, ANSI, and NEMA standards. The supplier shall identify the standards utilized.

TABLE 3-9

Isolation Transformer Characteristics

<u>Item</u>		
1	Type	Dry
2	Rating	To suit Cycloconverter 2200/842/842/842 KVA approximately
3	Enclosure	NEMA I, indoor
4	Core Type	Frame
5	Voltage	4160 Volts L-L, 60 Hz, 3 phase line side, 60 KV BIL minimum (3) isolated 3 phase windings, 525 V L-L, 60 Hz, converter side
6	Connection	Delta, line side WYE/WYE/WYE, converter side, TBD neutral
7	Cooling	Self-cooled
8	Impedance	To suit cycloconverter, with matched winding values
9	Losses	6 kW no load, 28 kW full load, maximum
10	Maintenance	Design shall be suitable for a six (6) month or more periodic inspection and maintenance interval
11	Life	Expected design life, with periodic maintenance, shall be 30 years. Insulation class and temperature rise shall be selected consistent with life.
12	Materials	Construction materials shall be inherently corrosion resistant or protected from corrosion due to exposure to airborne moisture and salt in cooling air per paragraph 3.2.2.3.
13	Altitude	Per paragraph 3.2.2.3
14	Space Heater (Option)	An anti-condensation heater, suitable for continuous energization shall be mounted and wired in the bottom of each equipment section. 208 VAC, 4 wire, 3 phase, 60 Hz power at 2 kW maximum will be provided by purchaser for balanced load heater operation.
15	Fault Protection	Provided by purchaser with 4160 volt circuit breaker
16	Sound	Sound level shall be less than 62 dBA

3.2.3.2 Isolation Transformer Parameters

The supplier shall provide the purchaser with the data shown in Table 3-10 within ten (10) weeks of receipt of order.

TABLE 3-10

Isolation Transformer Parameters

<u>Item</u>	
1	Weight (lb)
2	Outline drawing showing installation, handling and shipping package details, and access requirements
3	Connection drawing
4	Cooling air requirements (SCFM, psi drop, temperature rise)
5	Loss calculation at full load
6	Summary parts list and recommended spare parts list
7	Draft instruction books (final with delivery) including maintenance requirements
8	Auxiliary power requirements

3.3 FINISH

Finish paint properties and color shall be per Federal Standard No. 595A:

- | | | |
|----|-----------------------|------------------------|
| a) | Generator | Semigloss Blue (25177) |
| b) | Cycloconverter | Semigloss Blue (25177) |
| c) | Isolation Transformer | Semigloss Blue (25177) |

The supplier shall provide information on finish paint materials and application methods in order to permit field touch-up.

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3.4 MARKING

a) Generator

Stamped metal nameplates shall be secured to the machine frame showing relevant data on machine rating and manufacturer. Additional nameplates shall indicate rotation, stator connections, and rotor connections. A weatherproof terminal diagram and schematic shall be affixed to the inside cover of the instrumentation box. All leads shall be marked as noted on the connection diagrams.

b) Cycloconverter

Stamped metal nameplates shall be secured to the enclosure showing relevant data on unit rating and manufacturer. A weatherproofed elementary diagram book, showing connections, shall be supplied in a pocket affixed to the inside cover of the control compartment door. All terminal strips shall have identification of strip and terminal number clearly marked. All leads and devices shall be marked as noted on the connection diagrams.

c) Isolation Transformer Same marking requirements as Cycloconverter.

SECTION 4

4.0 QUALITY ASSURANCE

4.1 DESIGN MANUFACTURING AND TEST FLOW PLAN

The supplier shall submit a Design, Manufacturing and Test Flow Plan showing the basic design operations, manufacturing operations, reviews, and production tests for General Electric - AEPD review and establishment of inspection points. Long lead items shall be identified.

4.2 DESIGN REVIEWS

An informal design review shall be conducted at the completion of design, prior to fabrication. Two informal subsystem test reviews shall be conducted; one after procedures are documented prior to the test, and a second after the test to review results.

4.3 GENERAL ELECTRIC INSPECTION

General Electric shall maintain awareness of the supplier's quality assurance with respect to the material to be furnished under this specification. Where inspection points have been established per paragraph 4.1, the supplier shall notify General Electric - AEPD forty-eight (48) hours in advance of the time when inspection is to be conducted.

4.4 PRODUCTION TESTS

4.4.1 GENERAL

The supplier shall perform standard production tests on all equipment and supply test data measurements where established per paragraph 4.1.

4.4.2 GENERATOR

Generator production tests shall include at least:

- a) High potential test
- b) Insulation resistance test
- c) Rotor balance
- d) No-load loss measurement (motor conditions)
- e) Phase sequence
- f) Connection continuity, conformance to diagram
- g) Dimensional check, conformance to installation drawings
- h) Visual check for finish defects

4.4.3 CYCLOCONVERTER

Cycloconverter production tests shall include at least:

- a) Control wiring insulation megger
- b) Connection continuity, conformance to diagram
- c) Control functional check
- d) Dimensional check, conformance to installation drawings
- e) Visual check for finish defects

4.4.4 ISOLATION TRANSFORMER

Isolation Transformer production tests shall include at least:

- a) Connection continuity, conformance to diagram
- b) Ratio check
- c) High potential test
- d) Insulation resistance test
- e) Dimensional check, conformance to installation drawings
- f) Visual check for finish defects

4.5 SUBSYSTEM TEST

4.5.1 GENERAL

A subsystem test shall be performed on first hardware to demonstrate the capabilities of the various components with respect to requirements, obtain engineering data on operation, calibrate sensors, and generally shake down the equipment.

4.5.2 SUBSYSTEM EQUIPMENT

Generator

Cycloconverter and Control

Isolation Transformer

4.5.3 WIND TURBINE EQUIPMENT

Preferred

Switchgear Assembly with
Circuit Breakers, Relays,
Instrument Transformers,
Transducers, etc.

Turbine Controller with Wind
Turbine Simulator

Harmonic Filters and
Power Factor Capacitors

Optional (If preferred items unavailable)

Switching Devices and Instrument
Transformers

Test Switchbox with Manual Analog
Signal Settings

Nothing

4.5.4 TEST EQUIPMENT - SET-UP

- Variable speed drive motor and control capable of 0-1500 RPM operation at a shaft torque level of at least 13,500 ft-lb (35% of generator rating).
- Grid interface transformer with connection at 4160 V, 60 Hz, 3-Phase, 3500 KVA or higher capability

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4.5.4 TEST EQUIPMENT - SET-UP (cont'd)

- Anchors for securing generator and drive motor
- Test couplings for connection of generator shaft to drive motor shaft
- Interconnecting power cabling

4.5.5 INSTRUMENTATION

The test instrumentation shall be sufficient to sense and record system performance parameters. A detailed instrumentation plan shall be prepared and approved prior to test.

4.5.6 TEST REQUIREMENTS

A detailed test plan and schedule shall be prepared and approved prior to implementing test hardware. The following functions shall be tested.

- a) Motoring mode
- b) Synchronization at various accelerations
- c) Torque regulation at various accelerations and speeds
- d) Var regulation at various accelerations and speeds
- e) Calibration of switchgear transducers (if available)
- f) Harmonic current measurement at various speeds and converter power levels
- g) Generator bearing operation at 7° incline (actual or simulated)
- h) Measurement of lubrication and air cooling flow and temperatures
- i) Shutdown on loss of power

SECTION 5.0

PREPARATION FOR DELIVERY

The manufacturer shall submit a statement detailing the normal practice of packaging and method of delivery for continental and export destinations for approval by:

General Electric Company
Advanced Energy Programs Department
P.O. Box 527
King of Prussia, PA 19406

The method and destination will be identified two (2) months prior to shipment.

5.1 DOCUMENTS

- | | |
|--|------|
| o Certified detailed outline drawing | a, b |
| o Connection diagrams | a, b |
| o Complete instructions with parts list | b |
| o Detailed summary or equipment list | b |
| o Three (3) certified copies of test data | b |
| o Items in paragraph 3.2.1.2, 3.2.2.2, 3.2.3.2 | a |

5.1.1 DOCUMENT SUBMITTAL

Documents marked "a" shall be submitted for examination or approval within ten (10) weeks of order by sending two (2) copies to General Electric Company, Advanced Energy Programs Department, MOD-5A Engineering, P.O. Box 527, King of Prussia, PA 19406. Approval or comments will be returned within two (2) weeks of receipt.

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5.1.1 DOCUMENT SUBMITTAL (cont'd)

Documents marked "b" shall be supplied with shipment. One (1) mylar reproducible and ten (10) copies of each drawing shall be supplied. Twelve (12) copies of instruction books shall be supplied. In addition, one copy of all documents shall be enclosed with shipment.

Documents marked "a, b" shall meet submittal requirements of both "a" and "b".

47A380095

REV NO.	
47A380095	
CONT ON SHEET <u>ii</u>	SH NO. <u>1</u>

TITLE	
FIRST MADE FOR	

CONT ON SHEET <u>ii</u>	SH NO. <u>i</u>
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SPECIFICATION FOR THE CROSSED-ROLLER TYPE
THRUST BEARING
FOR THE
MOD-5A WIND TURBINE GENERATOR

APRIL 1983

REVISION

Sage Dunfee
Responsible Engineer

DATE: 5/4/83

W.C. Puan
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DATE: 5/5/83

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DATE: 5/5/83

Chief Engineer

DATE: _____

A. Chodor
Quality Assurance

DATE: 5/6/83

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WTG Integration

DATE: 5/1/83

TOTAL NUMBER OF PAGES 20

i

WTG
500
PRINTS TO

MADE BY	
ISSUED <u>5/10/83</u>	

APPROVALS	
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<u>A.E.P.</u>	DIV OR DEPT.
<u>KING OF PRUSSIA, PA.</u>	LOCATION

47A380095	
CONT ON SHEET <u>ii</u>	SH NO. <u>i</u>

REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

Revision	Page No.	Paragraph Number(s) Affected	Rev. Date	Approval
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1.0 SCOPE

This specification establishes the design, test and performance requirements for a thrust bearing to be used in the 7.3 MW MOD-5A Wind Turbine Generator.

2.0 APPLICABLE DOCUMENTS

2.1 STANDARDS

ASTM E45-63 Metal Cleanliness

AMS 2808 Identification of Forgings

2.2 DRAWINGS (GENERAL ELECTRIC)

47D381050 Crossed Roller Bearing Aft Hub Section

2.3 GENERAL ELECTRIC ENGINEERING AND PROCESSES INFORMATION SERIES (EMPIS)

F65A1A3 Corrosion-Resistant Phosphate Coating (with supplemental rust preventative oil dip).

2.4 MILITARY SPECIFICATIONS AND STANDARDS

MIL-I-8950 Ultrasonic Inspection, Wrought Metals

MIL-I-6868 Inspection Process, Magnetic Particles

MIL-STD-271 Non-Destructive Testing Requirements for Metals

MIL-STD-130 Identification and Marking

2.5 AMERICAN IRON AND STEEL INSTITUTE

AISI 52100 Steel, Chromium

2.6 STANDARDS - GERMAN

DIN 5402 Rolling Bearing Components, Cylindrical Roller, June 1973

3.0 DESIGN REQUIREMENTS

3.1 DESIGN

The thrust bearing shall be a crossed-roller type meeting the requirements of GE Drawing 47D381050 and this specification. The bearing will be mounted as shown in Figure 1.

3.1.1 THRUST

Nominal: +280,000±40,000 lbs (rotating) @ 2 cycles/revolution

Peak: +533,000 lbs, - 382,000 lbs

Note + and - denote normal and reverse directions of thrust respectively.

3.1.2 ROTATION

Low	13.7 RPM
Nominal	16.8 RPM
Maximum Speed	25 RPM @ 50% Overspeed
Duty Cycle	94%
Total Revolutions	228×10^6
Race Rotation	Outer

3.1.3 LIFE AND RELIABILITY

Service Life	30 years
30 Year Failure Rate	Less than 2%

3.1.4 OVERALL DIMENSIONS

The outline dimensions of the bearing shall be as shown on GE Drawing 47D381050.

3.1.5 WEIGHT

The weight of the assembled bearing, less any attaching devices or sealing hardware, shall not exceed value shown on drawing.

3.1.6 BEARING TYPE

The bearing shall be of the crossed roller configuration, with the rollers being nominally 2.00-3.00 in. in diameter with fully machined roller cage.

3.1.7 ENVIRONMENTAL CONDITIONS

The assembled bearing shall be capable of meeting the requirements of this specification during and/or after exposures to a temperature range from 0°F to +100°F, and exposure to airborne salt particles as found in coastal areas. The bearing shall survive, without degradation, a temperature range of -40°F to +120°F, non-operating.

3.1.8 MATERIAL

3.1.8.1 Races

The races shall be fabricated from AISI 4340 alloy steel or equivalent. The steel shall be of the electric furnace, vacuum degassed process.

3.1.8.2 Rollers

The rollers shall be made of AISI 52100 alloy steel or equivalent. Rollers shall be crowned per DIN 5402.

3.1.8.3 Test Bars

One test bar at least 16 inches long, with cross section representative of the races, and of the same heat of material shall be heat treated in the same lot as the bearing races. A cross section approximately one (1) inch thick shall be taken near the center of each bar. The cross section shall be metallurgically polished and etched. One hardness traverse (hardness vs. depth below surface) shall be made on each roller path near the center of roller loading. The polished, etched, and hardness tested cross sections and a written report of the hardness traverses shall be supplied to the procuring activity with each order for bearings.

3.1.9 HARDNESS

3.1.9.1 Races

The roller paths shall be preferentially hardened to RC 58 to RC 62 at the surface. Case depth of the finished ground roller paths shall be 0.250 inches minimum. Depth of case hardening is defined as the depth below the surface to hardness of RC 50. The "soft spot" on the outer race shall coincide with loading plug location.

The race material under and surrounding the case hardened roller path shall be hardened to RC 30-34.

3.1.9.2 Rollers

Rollers shall have a surface hardness of 58 R_C to 62 R_C after grinding. Minimum core hardness shall be 38 R_C .

3.1.10 STRUCTURAL INTEGRITY

The inner and outer races of the bearing must be capable of operating with defects of the size and location defined per MIL-I-8950 Class B without propagation to the point of structural failure. Structural failure is defined as the inability of the race structure to support the rotor for the specified life when the bearing is subjected to the load conditions defined in Section 3.1.1 of this specification. Sufficient information to perform a fracture mechanics analysis will be provided to the procuring activity.

3.1.11 SURFACE ROUGHNESS

Surface roughness shall be 125 RMS max. except as follows:

Raceways:	15 RMS max.
Rollers:	10 RMS max.

3.1.12 INCLUSION RATING AND CLEANLINESS

Race Material cleanliness, as determined in paragraph 4 (.2.7[A]) of ASTM E45-63, Method A, shall not exceed the following Jernkontoret (JK) levels:

Inclusion Rating, Worst Field				
Type	A	B	C	D
Thin	2.0	2.0	2.5	1.5
Heavy	1.0	1.0	1.5	1.0

3.1.13 SPECIFICATION CONTROL

Vendor shall verify specification control procurement of all materials.

3.1.14 FRICTION

Static Friction Torque 20,000 ft lbs max. (*)

Running Friction Torque 10,000 ft lbs max. (*)

(*) Ratings under loads specified in Paragraph 3.1.1

3.1.15 INTERNAL CLEARANCES

Axial clearance shall be $.010 \pm .001$ inch.

3.1.16 LUBRICATION

3.1.16.1 Factory Applied

Rollers - Baked on dry film (Electrofilm, Inc., Lubricant #2109)

Roller Paths - Air dry, dry film (Precision Products Co., CCL-102)

Assembled bearing to be prepacked full with Keystone 84EP Light grease or equal.

3.1.16.2 Operating

While operating, the bearing shall be grease lubricated using Keystone 84EP Light grease or equal.

3.2.16.3 Lubrication Inlets

Inlets for supplying lubricant during operation shall be incorporated into the inner race as shown on GE Drawing 47D381050.

3.1.17 FITS AND TOLERANCES

3.1.17.1 Fits

The manufacturer shall specify fits of the bearing with the housing and shaft.

3.1.17.2 Runout

The maximum axial runout of the inner race rotating relative to the outer race shall be .003" T.I.R. The maximum radial runout of the inner race rotating relative to the outer race shall be 0.003" T.I.R. These tolerances apply with a nominal thrust applied for axial and radial readings respectively.

3.1.17.3 Roller Diameter Variation

The average diameter of the rollers within any row of the bearing shall be matched within .0002".

3.1.18 LIFTING PROVISIONS

Three (3) tapped holes for eyebolts shall be provided, located as shown on GE Drawing 47D381050. Eyebolts with a strength factor of safety of 6 shall be supplied with the bearing.

3.1.19 FINISH

All surfaces of bearing and gear with the exception of the roller paths shall be coated with a zinc-phosphate coating per GE EMPIS F65A1A3.

3.2 SPECIAL MARKINGS

GE Part Number 47D381050 shall be etched on outer race, vertical surface at 90° intervals, normal and reverse thrust direction.

3.3 WORKMANSHIP

The bearing shall be constructed in a thorough workmanlike manner. All parts shall be free of burrs, sharp edges and other damages or defects that could make the unit unsatisfactory for the operation or function intended.

3.4 LOADING PLUG - SEAMLESS FORGED LOW CARBON STEEL AISI 1010 OR 1020

Clearance on diameter, between loading plug and race, shall be .005 in. maximum. The roller path of the loading plug shall be relieved by .015" to .030", with a smooth transition between plug and race. The blend shall be accomplished over one roller diameter. The plug shall be attached to the race as shown on GE Drawing 47D381050.

3.5 IDENTIFICATION MARKINGS

3.5.1 GENERAL

Identification marking shall be in accordance with MIL-STD-130 and shall include the following:

- a) Manufacturer's name, symbol, or code identification
- b) Manufacturer's part number, lot number and serial number.

3.5.2 LOCATION AND TYPE OF MARKING

Marking shall be electro-etched with 1/4" high characters located in a non-loaded zone.

3.5.3 FORGINGS

Forgings shall be identified in accordance with AMS 2808. Material that cannot be identified at destination shall be cause for rejection.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 QUALITY CONTROL/INSPECTION

The bearing manufacturer shall provide a brief description of his Quality Control/Inspection system showing how he controls:

- a. Measuring and Test Equipment
- b. Processes
- c. Materials
- d. Non-Conforming Materials

4.2 TORQUE MEASUREMENT

Breakaway torque for the loaded bearing shall be measured at six (6) equally spaced locations over one (1) revolution prior to delivery to General Electric. Running torque at 1 rpm shall be measured over 1.5 revolutions. Data shall be recorded and submitted to General Electric.

4.3 INSPECTION

4.3.1 DRAWING COMPLIANCE

Prior to shipment, the finished bearing shall be inspected for conformance with GE Drawing 47D381050. Any deviation shall be reported to the procuring office for resolution before shipment.

4.3.2 LOADING PLUG BLEND

The blend between loading plug and race along roller path shall be checked for conformance with paragraph 3.4 of this specification.

4.4 TEST BARS

The test bar reference in 3.1.8.3 shall be processed in the same manner as and simultaneously with the bearing races. A cross section approximately 1 inch thick shall be taken near the center of the test bar. The cross section sample shall be metallurgically polished and etched to show the pattern of roller path case hardening. A written report of the hardness traverse shall be supplied to GE.

4.5 REPLICA TAPE REQUIREMENT FOR RACES

Each finished ground roller path shall be metallographically polished, Nital etched with five (5) percent solution, neutralized, and recorded by replica tape techniques every 90° of circumference. (Four (4) tapes per roller path, eight (8) tapes per individual race, sixteen (16) tapes per bearing.)

The replica tapes shall be approximately one-half by two inch (1/2 x 2") and marked with an "O" to indicate the area near the groove center and placed in separate envelopes. Each envelope shall contain the following information:

- a. Part number
- b. Serial number
- c. Upper or lower roller path
- d. Location from an identifying bench mark in clockwise direction
- e. Date of replica

Each replica tape shall be examined by vendor under an optical microscope at 100X. Minimum acceptance martensite shall be an area of 85%. Any evidence of grinding burns, rehardened areas, or cracks shall be cause for rejection. Non-Martensite phases, if any, shall be finely dispersed through the microstructure.

4.6 ULTRASONIC INSPECTION

All forgings shall be ultrasonically inspected for soundness per MIL-STD-271. All significant indications shall be noted and the material identified so that subsequent re-examination can be made. Rings shall be free of all harmful defects.

4.7 MAGNETIC PARTICLE INSPECTION, ROLLER PATHS

The finished roller paths shall be inspected 100% using magnetic particle method per MIL-I-6868 using the wet method.

4.7.1 ACCEPTANCE CRITERIA

Any indications of the following type are not acceptable:

- a) Crack of any type
- b) Surface indications caused by flaking, forging bursts, intruded forging scale, laps, linear porosity or tears.
- c) Corrosion pits
- d) Non-metallic inclusions exceeding the following limits:
 - 1) Any non-metallic indication surface or subsurface larger than .125
 - 2) More than three (3) indications per square inch of raceway counting all indications larger than .0625.

4.7.2 RELIEF OF NON-METALLIC INCLUSIONS

Relief of non-metallic inclusions over .06" long but less than .125" long is permitted to the extent indicated below. Indications of non-metallic inclusions greater than .125" long shall be rejected.

- a) Reliefs in each roller path shall be spaced at least a 30° arc apart. The two major load carrying roller paths shall have no more than a combined total of twelve (12) reliefs for the two roller paths. This allows a maximum of twelve (12) reliefs for the two major load carrying paths.
- b) No relief shall exceed .25" long by .125" wide.
- c) All indications that are relieved shall be eliminated within the allowable relief length and width within .030" depth.

4.8 TEST DATA

The following data shall accompany the shipment:

- a) Three (3) certified copies of test data identified in paragraph 4.3.
- b) Test data, including breakaway torque and test results on the sample forging.
- c) Copies of actual ultrasonic, penetrant inspection, test reports for forgings.
- d) Evidence of conformance to special processes, i.e.: phosphate coating, heat treatment, stress relief.
- e) Blend of loading plug with roller path of outer race.
- f) "Foot Print" of roller crowning impressed in metallic tape.

4.9 TEST NOTIFICATION

General Electric procurement shall be notified forty-eight (48) hours in advance of:

- a) Breakaway torque test
- b) Final inspection

4.10 ENGINEERING REPORT

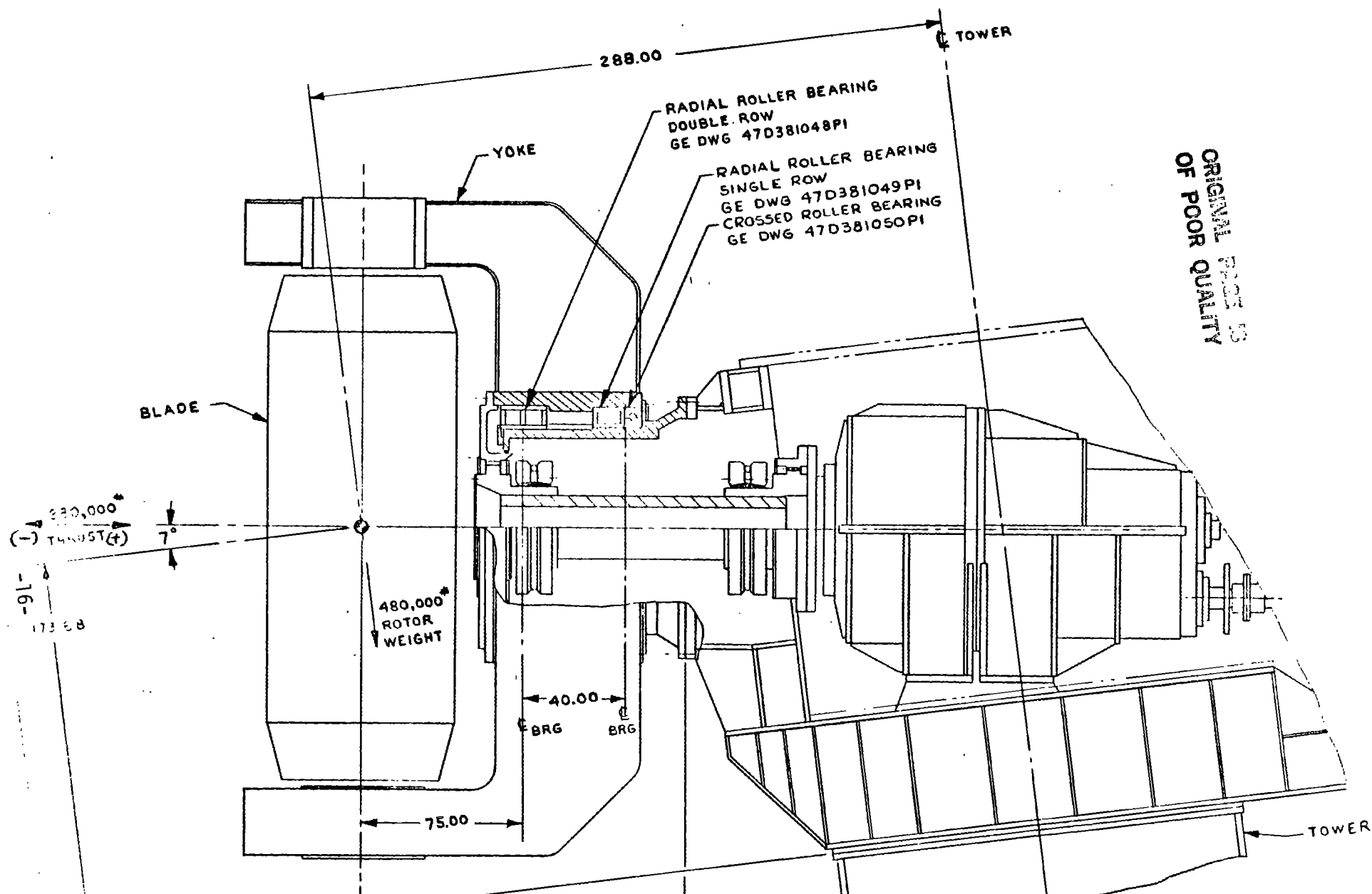
Prior to manufacture of the bearing, three (3) copies of an Engineering Report shall be submitted for General Electric Company approval. The Engineering Report shall contain as a minimum:

- a) Load Analysis - Bearing (Include roller crown effects)
- b) Spring Rate - Axial
- c) Service Life Analysis
- d) Starting Torque, Running Torque Calculations
- e) Lubrication Recommendations, Schedule and Technique
- f) Mounting Recommendations
- g) Raceway and roller hardening techniques and test methodology.
- h) Computer Analysis
- i) Drawings

5.0 DELIVERY

Shipping containers and method of shipment shall be approved by General Electric Company prior to shipment.

Mod-5A WTG
47A380095
APRIL 1983



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SH NO. *i*

FIRST MADE FOR

REVISION

SPECIFICATION FOR THE CYLINDRICAL ROLLER,
RADIAL ROTOR SUPPORT BEARINGS
FOR THE
MOD-5A WIND TURBINE GENERATOR

APRIL 1983

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Responsible Engineer

DATE: *5/3/1983*

W.C. Luecke
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DATE: *5/11/83*

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DATE: *MAY 11, 1983*

J. H. Luecke
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DATE: *5/11/83*

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DATE: *5/9/83*

J. L. Linker
WTG Integration

DATE: *5/10/83*

TOTAL NUMBER OF PAGES 26

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APPROVALS

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DEPT.

ISSUED

J. H. Luecke *5/12/83*

KING OF PRUSSIA, PA.

LOCATION

47A380096

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SH NO. *i*

REVISION LOG

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SECTION 1

SCOPE

This specification defines the technical requirements for a radial bearing set which will support the rotor of the MOD-5A Wind Turbine Generator.

SECTION 2
APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein.

DRAWINGS - GENERAL ELECTRIC

47D381048 Radial Roller Bearing - FWD
47D381049 Radial Roller Bearing - AFT

SPECIFICATIONS - MILITARY

MIL I-6868 Inspection Process, Magnetic Particle
MIL I 8950 Ultrasonic Inspection, Wrought Metals
MIL-I-45208 Inspection System Requirements

STANDARDS - MILITARY

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-271 Non-destructive Testing Requirements for Metals

STANDARDS - GERMAN

DIN-5402 Rolling Bearing Components, Cylindrical Rollers, June 1973

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity).

2.1 OTHER PUBLICATIONS

The following documents form part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or requests for proposal shall apply.

AMERICAN IRON AND STEEL INSTITUTE

AISI 52100 Steel, Chromium
AISI E3310 Carburizing Steel

SOCIETY OF AUTOMOTIVE ENGINEERS, INCORPORATED

AMS 2808 Identification - Forgings

(Applications for copies should be addressed to the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York, New York, 10017).

AMERICAN SOCIETY FOR TESTING MATERIALS

ASTM E112-63 Estimating and Average Grain Size of Metals
ASTM A485 Forging Steel
ASTM E45-63, METHOD A Determining the Inclusion Content of Steel

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA, 19103).

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION, INCORPORATED

AFBMA Standards, Section 17, Class 4

(Application for copies should be addressed to the Anti-Friction Bearing Manufacturer's Association, Inc., 60 East 42nd Street, New York, NY, 10017).

SECTION 3 REQUIREMENTS

Requirements for individual bearings shall be as specified herein and in accordance with GE Dwg. 47D381048 and 47D381049 or equivalent configurations which are within the envelope defined on the drawings.

3.1 PERFORMANCE CRITERIA

3.1.1 LOADING

The loads are applied from the outer race (rotating) to the stationary inner race.

3.1.2 LIFE REQUIREMENTS

The bearing shall be capable of operating for a minimum of 228×10^6 revolutions, when subjected to the requirements of Section 3.1.3 and 3.1.4. The failure rate of the bearing shall be less than 2% over the 30 year life of the WTG.

3.1.3 ROTOR SUPPORT REQUIREMENTS

The rotor bearings shall be mounted on the stationary hub of the rotor support structure to support the rotor. The bearings, accordingly, must be capable of resisting the loads imposed by the mass and dynamics of the rotor system. Figure 1 shows the specific bearing arrangement and loading geometry. Table 1 lists pertinent performance requirements.

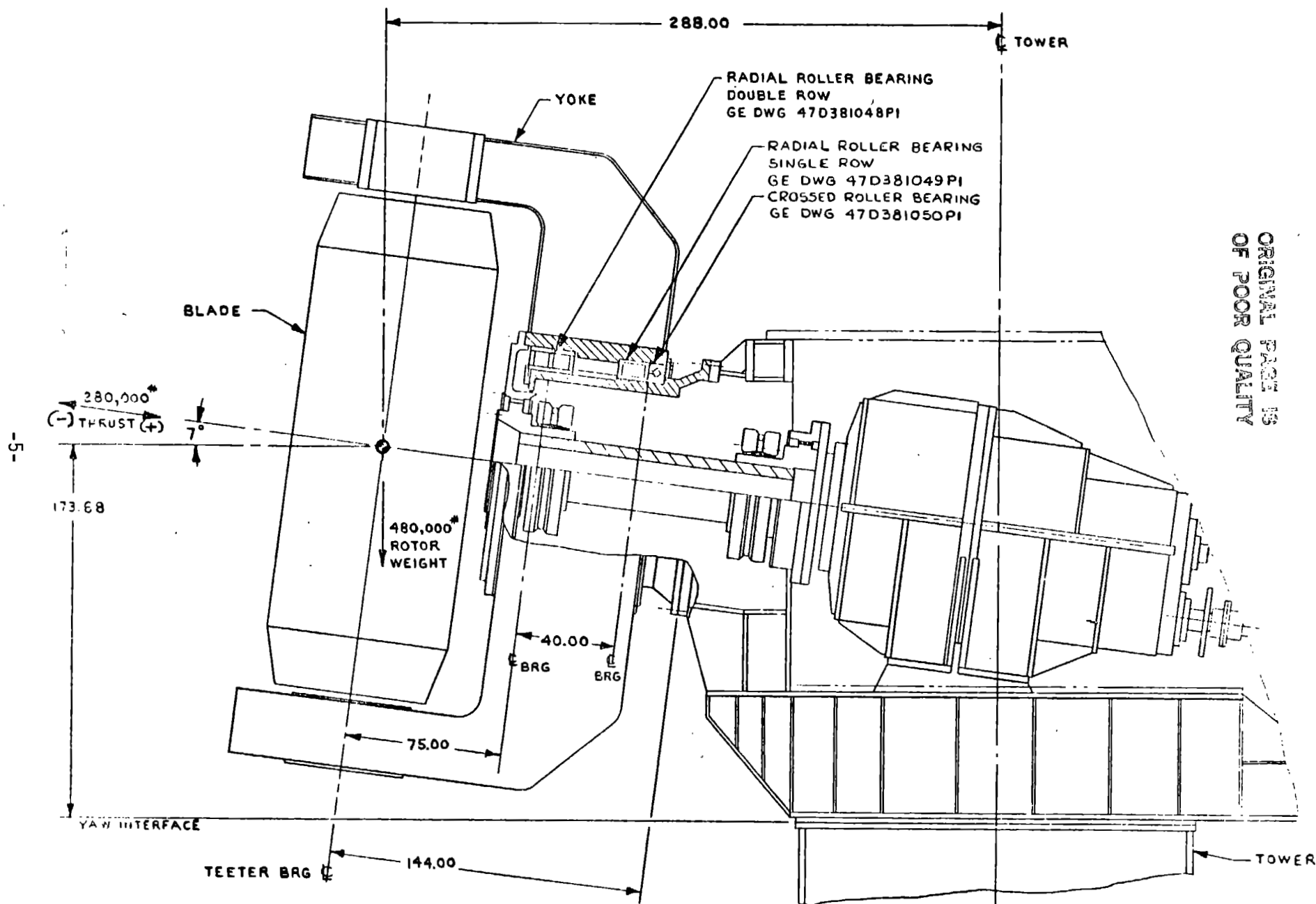


FIG #1 ROTOR SUPPORT BEARING ASSEMBLY

TABLE 1 - PERFORMANCE REQUIREMENTS

Input Speed - Nominal	16.8 RPM (50% of time)
Input Speed - Low	13.7 RPM (44% of time)
Maximum Speed - 50% Overspeed	25 RPM
Non-rotating	6% of time
Maximum Running Losses/Bearing	1/3% at rated power (33 HP @ 16.8 RPM)
Direction of Rotation	Clockwise when looking along low speed shaft into the gearbox. Outer race rotation.
Design Load	See Drawing 47D381048 and 47D381049

3.1.4 ENVIRONMENTAL CONDITIONS

The assembled bearings shall be capable of meeting the requirements of this specification during and/or after exposures to a temperature range of 0°F to +100°F, and exposure to salt spray as found in coastal areas. The bearing shall survive, without degradation, a temperature range of -40°F to +120°F, non-operating.

3.1.5 WEIGHT

The weight of the assembled bearing, less any attaching devices or sealing hardware, shall not exceed the weight shown on the referenced drawing.

3.2 DESIGN AND CONSTRUCTION

3.2.1 GENERAL

The design and construction of the bearing shall not exceed the envelope shown on the respective GE Dwg. specified in the purchase order.

3.2.2 STRUCTURAL INTEGRITY

The inner and outer races of the bearing must be capable of operating with defects of the size and location defined per MIL-I-8950 Class B without propagation to the point of structural failure. Structural failure is defined as the inability of the race structure to support the rotor for the specified life when the bearing is subjected to the load conditions defined in Section 3.1 of this specification. Sufficient information to perform a fracture mechanics analysis shall be provided to the procuring activity.

3.2.3 LUBRICATION AND SEALING

The rollers and cages of the bearing will be grease lubricated with Keystone EP 84 Light or equal. This lubricant will be supplied from an automatic lubrication pump. The manufacturer shall provide lubrication penetration holes in the inner races of the bearings as shown on referenced drawings. Provisions for lubricant fittings, and distribution and circulation of the lubricant within the bearing, shall be the responsibility of the purchaser. The manufacturer shall recommend the grease seal design to keep the rate of grease injection to a minimum and to protect the bearing under the environmental conditions shown in paragraph 3.1.4

3.2.4 ROLLER CAGE

The cage must be designed to withstand all roller loading without detrimental wear for the specified life of the bearing when subjected to the loads defined on the referenced drawing. For pin type cages the vendor shall specify hardness, surface finish and internal clearance.

3.2.5 FITS AND TOLERANCES

3.2.5.1 Fits

The manufacturer shall specify fits of the bearing with the housing and shaft at a reference temperature of 20°C.

3.2.5.2 Runout

The maximum axial runout of the inner race rotating relative to the outer race shall be 0.005" T.I.R. The maximum radial runout of the inner race rotating relative to the outer race shall be 0.0035" T.I.R. These tolerances apply at the nominal loads shown on drawing for radial readings.

3.2.5.3 Roller Diameter Variation

The average diameter of the rollers within a row of the bearing shall be matched within .0002".

3.2.5.4 Internal Diametral Clearance - Installed

The internal diametral clearance shall be .002" to .008".

3.2.6 SURFACE ROUGHNESS

Surface roughness shall be 125 RMS max. except as follows:

Raceways:	12 RMS max.
Rollers:	8 RMS max.

3.3 MATERIALS

3.3.1 RACES

Material shall be forged and rolled ring steel per ASTM A485 Grade 2, or AISI 4340. The steel shall be of the electric furnace, vacuum degassed process.

3.3.2 ROLLERS

Material shall be AISI E-3310 modified carburizing steel, or AISI E-52100 through hardening steel. The steel shall be of the vacuum remelt process. Rollers shall be crowned per DIN 5402.

3.3.3 ROLLER CAGES AND PINS

Materials must be compatible with the loads, speeds and lubrication defined in paragraphs 3.1 and 3.2 of this specification. Rollers shall be crowned per DIN 5402.

3.3.4 SPECIFICATION CONTROL

Vendor shall verify specification control procurement of all materials.

3.3.5 INCLUSION RATING AND CLEANLINESS

Race Material cleanliness, as determined in paragraph 4 (.2.7[A]) of ASTM E45-63, Method A, shall not exceed the following Jernkontoret (JK) levels:

Inclusion Rating, Worst Field

<u>Type</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Thin	1.5	1.5	2.0	1.5
Heavy	1.0	1.0	1.5	1.0

3.4 HEAT TREATMENT AND HARDNESS

3.4.1 RACES

Rough machined forgings shall be fully spheroidized annealed. No pearlitic structure, ferrite network or carbide network shall be allowed. The maximum hardness of the rough machined forgings shall be 220 BHN.

3.4.2 ROLLER PATH HARDNESS

Roller paths on the inner and outer races shall be hardened and tempered (375°F min.) to a surface hardness of 58 Rc to 62 Rc to a minimum depth of 0.5 inches. Grain size shall be 5 or finer.

3.4.3 TEST BARS

One test bar, at least 16 inches long, with cross section representative of the races, and of the same heat of material shall be heat treated in the same lot as the bearing races. A cross section approximately one inch thick shall be taken near the center of each bar. The cross section shall be metallurgically polished and etched. One hardness traverse (hardness vs. depth below surface) shall be made on each roller path near the center of roller loading. The polished, etched, and hardness tested cross sections and a written report of the hardness traverses shall be supplied to the procuring activity with each order for bearings.

3.4.4 ROLLERS

Rollers shall have a surface hardness of 58 Rc to 62 Rc after grinding. When using a case hardenable steel, the depth of case (where the minimum hardness shall be 50 Rc) shall be .200" minimum and with a minimum core hardness of Rc 35 to prevent case or core fatigue failure when the bearing is subjected to the load conditions specified in paragraph 3.1 of this specification. Grain size shall be 5 or finer.

3.5 WORKMANSHIP

The bearing shall be constructed in a thorough workmanlike manner. All parts shall be free of burrs, sharp edges and other damages or defects that could make the unit unsatisfactory for the operation or function intended.

3.6 IDENTIFICATION MARKINGS

3.6.1 GENERAL

Identification marking shall be in accordance with MIL-STD-130 and shall include the following:

- a) Manufacturer's name, symbol, or code identification
- b) Manufacturer's part number, lot number and serial number

3.6.2 LOCATION AND TYPE OF MARKING

Marking shall be electro-etched with 1/4" high characters located in a non-loaded zone.

3.6.3 FORGINGS

Forgings shall be identified in accordance with AMS 2808. Material that cannot be identified at destination shall be cause for rejection.

3.7 LIFTING PROVISIONS

Each race shall contain tapped holes for eye bolts as shown on referenced drawing. Eye bolts with a strength safety factor of six (6) shall be provided with each race.

SECTION 4
QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

4.1.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection and tests specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the procuring activity. The procuring activity reserves the right to perform any of the inspections and tests set forth in this specification where such inspections and tests are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 INSPECTION PROVISIONS

4.2.1 TEST PROCEDURE

4.2.1.1 Preparation

The procedure and methods for performing all tests specified herein shall be prepared by the supplier.

4.2.1.2 Approval

Test procedures shall be submitted to the procuring activity for approval prior to initiation of formal testing. The procuring activity reserves the right to require additional tests to determine compliance with the requirements of this specification.

C - 3

4.2.2 CLASSIFICATION OF TESTS

Tests shall be classified as follows:

- a) Acceptance test (see 4.3)

4.2.3 TEST CONDITIONS AND TOLERANCES

4.2.3.1 Temperature

All static and dynamic tests shall be performed at room ambient temperature.

4.2.3.2 Dimensional Checks

All dimensions shall be measured using instruments calibrated to reference standards at 20°C. The reference standard to be certified by the National Bureau of Standards. Standard gauges shall be used for checking all radii chamfers, tapped, and drilled holes.

4.2.4 MAGNETIC PARTICLE INSPECTION

4.2.4.1 Non-Operating Surfaces

The non-operating surfaces, other than roller paths, shall be inspected 100% by magnetic particles per MIL-I-6868 using the wet method.

4.2.4.1.1 Acceptance Criteria

Any indications of the following types are not acceptable:

- a) Cracks deeper than .010. No crack shall extend into a hole or fillet. All cracks less than .010 shall be relieved.
- b) Seams and laps deeper than .010. No seams or laps shall extend into a hole or fillet. All seams and laps shall be relieved.
- c) Surface indications caused by flaking, forging burst, intruded forging scale deeper than .010 and/or covering more than 15% of the surface.
- d) Corrosion pits except for isolated areas no larger than .0625 diameter by .010 deep.

4.2.4.2 Rings Including Roller Paths

The finished rings and roller paths shall be inspected 100% by magnetic particles per MIL-I-6868 using the wet method.

4.2.4.2.1 Acceptance Criteria

Any indications of the following type are not acceptable: cracks of any type; surface indications caused by flaking, forging burst, intruded forging scale, laps, linear porosity, tears, corrosion pits or non-metallic inclusions.

4.2.4.2.2 Ultrasonic Inspection

Rings shall be ultrasonically inspected as partially machined forgings. No indications are permitted within .1 inch of roller path surface.

4.2.4.2.3 Nital Etch

All roller paths are to be nital etched with a 3% nital solution at 4 equally spaced locations on each roller path over a 2" wide segment at each location. The races are to be cleaned with alcohol and nital etched for 30 seconds. Rewash with alcohol and treat with a 10% solution of NaOH to neutralize the etch. After examination the races shall be coated with a light oil to prevent corrosion.

4.2.4.2.3.1 Acceptance Criteria. No grinding burns or rehardened areas shall be permitted.

4.2.4.3 Rollers

Rollers shall conform to the material specification of 3.3.2 and meet specification requirements of paragraph 3.3.4. Rollers shall be inspected 100% by magnetic particles per MIL-I-6868 using the wet method. Acceptance criteria shall be per paragraph 4.2.4.2.1.

4.2.4.4 Test Pieces

A roller shall be sectioned and microscopically examined and a hardness traverse made to demonstrate compliance with the requirements of paragraph 4.2.4.3. No carbide network shall be permitted.

4.2.5 FINAL NITAL ETCH

Four matched rollers from each lot for use in each specific bearing shall be nital etched by the supplier. These rollers shall not be assembled into the finished bearing. Any indication of grinding burns, cracks, pits or decarburization shall be cause for rejection of the entire lot.

4.2.6 FORGINGS INSPECTION

4.2.6.1 Microstructure

Radial specimens, approximately 0.28" square in surface area, taken midway between center and surface of the test bar, shall be polished on a face longitudinal to the direction of rolling, for microinclusion rating in accordance with the Jernkontoret Chart, Method A, Plate I of ASTM E45. Ratings shall meet the requirements of paragraph 3.3.5 of this specification.

4.2.6.2 Macrostructure

Visual examination of transverse sections from billets, etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at 160-180°F for sufficient time to develop a well-defined macrostructure, shall show no imperfections such as pipe cracks, porosity segregation and inclusions which may be detrimental to fabrication or performance.

4.2.6.3 Ultrasonic Inspection

All forgings shall be ultrasonically inspected for soundness per MIL-I-8950, Class B. All significant indications shall be noted and the material identified so that subsequent re-examination can be made. Rings shall be free of all harmful defects.

4.2.7 QUALITY CONFORMANCE INSPECTION

Each unit shall be examined and acceptance tested per paragraph 4.3.

4.2.8 TEST SUCCESS CRITERIA

Any deviation from the performance parameters specified herein/or any physical/mechanical out-of tolerance condition that is noted during or after the performance of the tests specified herein shall constitute a failure of the unit.

4.3 ACCEPTANCE TEST

Each unit shall be subjected to and shall have passed the following tests prior to acceptance by the procuring activity.

TEST	TEST METHOD REFERENCE
Examination of Product	4.3.1
Identification	4.3.2
Weight	4.3.3
Workmanship	4.3.4
Performance	4.3.5

4.3.1 EXAMINATION OF PRODUCT

Examine each unit for strict conformance to 3.2.1 and 3.2.6

4.3.2 IDENTIFICATION

Examine each unit and check for conformance to the requirements of 3.6.

4.3.3 WEIGHT

Weigh each unit for conformance to drawing.

4.3.4 WORKMANSHIP

Examine each unit to verify conformance to 3.5

4.3.5 PERFORMANCE TESTS

Each unit shall be tested in accordance with the approved acceptance test procedure submitted in accordance with 4.2.1. The tests shall include measurement of breakaway and running torque under weight of the races only, with the bearing axis in the horizontal position.

4.3.6 ACCEPTANCE INSPECTION

Acceptance Inspection of rollers shall be performed by sampling per MIL-STD-105, Level II, AQL 1.0% defective.

The certified reports shall be submitted as an attachment to the shipping papers. The report shall include the following as part of the certification:

- a) Chemical composition of races, rollers and cages.
- b) Heat number of rollers, races and test bars.
- c) Photomicrographs of races and rollers test sample at 500 x showing core and surface microstructure, and case hardening pattern.
- d) Surface and case hardness traverse (Rc) of races and rollers and roller paths. Hardness of rough machined forgings (BH11). Core hardness of races and rollers (Rc).
- e) Depth of race and roller path case in thousandths of an inch.
- f) Heat treat lot number of races, rollers and appropriate test bars.
- g) For through hardened races, one hardness traverse (hardness vs. depth below surface) shall be made on each roller path of the test bar near the center of the roller loading (minimum of two hardness tested cross sections) and a written report of the hardness traverse shall be supplied to the procurer for each order of bearings. See paragraph 3.2.4.
- h) Grain size of rollers and races per ASTM E112-63.
- i) Cleanliness ratings per ASTM E45, Method A.
- j) Results of magnetic particle inspection per MIL-I-6868.
- k) Results of ultrasonic inspection per MIL-I-8950, Class B noting all discrepant defects.

2.3.6 ACCEPTANCE INSPECTION (cont'd)

- l) Results of macro acid etch per paragraph 4.2.6.2.
- m) Results of nital etch inspection showing that no grinding burns exist.
- n) Torque or Performance Test.
- o) Results of dimensional checks.

SECTION 5
PREPARATION FOR DELIVERY

The completely assembled bearing shall be prepacked with Keystone EP 84 Light, or equal, grease and tire wrapped per manufacturer's commercial practice. Kraft paper shall not be used. The bearing shall be crated for shipment and shall be constructed in a manner that will preclude damage or contamination.

SECTION 6.0

NOTES

6.1 ORDERING DATA

Procurement documents should specify the following:

- a) Title, number, and date of this specification.
- b) Number of the applicable detail specification and the revision letter.
- c) Levels of preservation, packaging, packing, and applicable marking.
- d) Method of sampling if other than specified.


6.2 CERTIFICATION

All quality conformance inspection data shall be recorded and a copy submitted to the procuring activity along with a notarized certificate of conformance at the time of bearing delivery. The data shall include all those listed in paragraph 4.3.6

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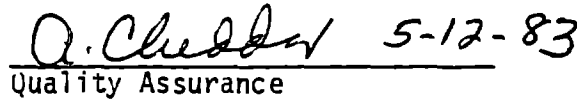
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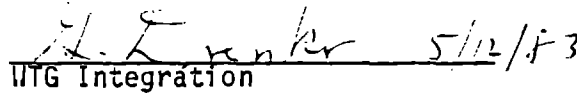
SPECIFICATION FOR A
WTG SWITCHGEAR ASSEMBLY
VARIABLE SPEED SYSTEM
MAY 1983


Responsible Engineer


Subsystems Engineer


Systems Engineering


Quality Assurance

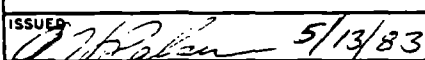

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REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

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SECTION 1.0

SCOPE

1.1 INTRODUCTION

This specification establishes the requirements for an indoor switchgear assembly for use on the MOD-5A Wind Turbine Generator.

The indoor metalclad switchgear described in this specification is intended for use on a 4160 Volt, three (3) phase, 60 Hertz system. The switchgear shall be rated 4160 Volts and shall have removable-element vacuum circuit breakers. The enclosure and circuit breaker either individually or as a unit, shall have a basic impulse rating of 60 KV. The switchgear, including circuit breakers, meters, relays, etc. shall be factory tested.

SECTION 2.0
APPLICABLE DOCUMENTS

The following documents of the date of issue noted form a part of this specification to the extent specified herein. In the event of conflict between this specification and the documents referenced herein, the contents of this specification shall supersede.

2.1 GENERAL ELECTRIC

47E387080 - One Line Diagram

2.2 INDUSTRY STANDARDS

NEMA - National Electrical Manufacturers Association

NFPA - No. 70-1981

National Electrical Code

OSHA - Occupational Safety And Health Act

ANSI - American National Standards Institute

C37.2 Manual and Automatic Station Control, Supervisory and Associated Telemetering Equipments

C57.13 Requirements for Instrument Transformers

Y32.2 Graphic Symbols for Electrical and Electronic Diagrams

Y14.15 Electrical and Electronic Diagrams

C37.20 Switchgear Assemblies including Metal Enclosed Bus

SECTION 3.0 REQUIREMENTS

3.1 ENVIRONMENTAL

The switchgear assembly conforming to this specification shall be suitable for operation at the nameplate rating provided that:

- (1) The temperature of the cooling air surrounding the enclosure of the switchgear assembly (ambient temperature) is within the limits of minus 30°C and plus 40°C.
- (2) The altitude does not exceed 3300 feet. Switchgear operation at altitudes in excess of 3300 feet will be subject to customer derating per manufacturer's instructions.

3.2 STATIONARY STRUCTURE

The switchgear shall consist of three (3) breaker units and a fused load break switch for a 300 KVA auxiliary power transformer assembled to form a rigid, self-supporting, completely metal-enclosed structure. In each unit, the major parts of the primary circuit such as the circuit breaker, buses, potential transformers and control power transformers shall be completely enclosed by grounded metal barriers. This shall include an inner barrier in front of, or as a part of the circuit breaker.

3.2.1 CIRCUIT BREAKER COMPARTMENT

Each circuit breaker compartment shall be designed to house 4160 Volt, removable-element circuit breakers. The stationary primary-disconnecting contacts shall be constructed of silver-plated copper. Grounded-metal safety shutter shall be provided which isolate all primary connections in the circuit breaker compartment when the breaker is withdrawn from the connected position.

3.2.2 GROUND BUS

A ground bus of 1/4-inch by 2-inch copper shall be extended throughout the lineup with connections to each breaker grounding contact and each cable compartment ground terminal. All joints shall be made with at least two 3/8-inch zinc-plated, iridite-dipped steel bolts per joint. Station ground-connection points shall be located in each end section.

3.2.3 BUS COMPARTMENT

The main bus shall be rated at 2000 amperes. Bus bars shall have a continuous current rating, in accordance with ANSI standards of temperature rise and documented by design tests. All joints will be silver plated with at least two bolts per joint. Bus bars will be braced to withstand the magnetic stresses developed by currents equal to the main power circuit breaker close, carry, and interrupt ratings. The bus shall be provided with front access through removable panels.

3.2.4 MATERIALS

Materials used in the switchgear assembly shall be inherently corrosion resistant or protected from corrosion due to exposure to airborne moisture and salt in the operational environment. For corrosion analysis assume 0.005 PPM maximum salt content in environmental air after filtration for sea coast installation.

3.2.5 FINISH

All steel surfaces shall be chemically cleaned and treated to provide a bond between the primer paint and metal surfaces. The switchgear exterior will be finished with air-dried acrylic lacquer paint of gray color (ANSI 61).

3.2.6 HEATERS

To minimize the occurrence of moisture condensation in the switchgear, a 300 watt heater shall be used in each vertical section for operation from a 120 VAC, 60 Hz source. Heaters shall be selected to operate at reduced voltage for extended life.

3.2.7 SIZE

The maximum dimensions of the switchgear assembly shall not exceed the dimensions shown in Figure 3.1

3.2.8 WEIGHT

The maximum weight of the switchgear assembly shall not exceed TBD pounds.

3.3 CIRCUIT BREAKERS

The circuit breakers shall be rated 4160 Volts, 60 Hz, with a continuous current rating as specified in Tables 3.2, 3.4, and 3.6 and a nominal interrupting rating of 250 MVA. All circuit breakers of equal rating shall be interchangeable.

The circuit breaker shall be operated by an electrically trip-free, stored-energy operating mechanism. Provision shall be included for manual charging of the mechanism and for slow closing of the contacts for inspection or adjustment.

The circuit breaker shall be equipped with secondary disconnecting contacts, which shall automatically engage in the operating positions.

The breaker compartment shall be furnished with a mechanism which will move the breaker between the operating and disconnect positions. The mechanism shall be designed so that the breaker will be self-aligning and will be held rigidly in the operating position without the necessity of locking bars or

3.3 CIRCUIT BREAKERS (Continued)

bolts. In the disconnect position, the breaker shall be easily removable from the compartment.

Interlocks shall prevent moving the breaker to or from the operating position unless its contacts are in the open position. As a further safety precaution, the operating springs shall be discharged automatically when the breaker is rolled fully into the compartment or is moved into the disconnect position. Means shall be provided for padlocking the breaker in either the connected (operating) position or the disconnected position. When locked in the disconnected position, the breaker shall be removable from the compartment. Padlocking shall not interfere with operation of the breaker or its mechanism. The circuit breaker control voltage shall be 125 volts dc. Each circuit breaker shall be equipped with 6 each "a" and "b", auxiliary contacts wired to a terminal board within the switchgear enclosure for user applications. Indicator lamps shall be provided and labeled on the front panel of the switchgear to indicate circuit breaker position.

3.4 INSTRUMENT TRANSFORMERS

3.4.1 CURRENT TRANSFORMERS

Current transformers shall have a relay and metering accuracy of 0.3 B-2 with ratios specified on the one-line diagram. The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers, and shall be insulated for full voltage rating of the switchgear.

3.4.2 POTENTIAL TRANSFORMERS

Potential transformers shall be drawout type, equipped with current-limiting fuses, and shall have an accuracy of .3-1.2Z. The ratio shall be as indicated on the one-line diagram.

3.5 DEVICES

All protection, instrumentation, and control devices shall be General Electric type, as indicated, or approved equivalent. Device numbers are in accordance with ANSI C37.2. LAMACOID labels or approved equivalent, describing the function, shall be provided on the panel. A 125 VDC Control Power Circuit shall be used.

3.6 WIRING

All secondary wiring shall be tinned copper, 600 volt switchboard wire.

- A. All wiring shall be adequately supported by vertical and horizontal wire ducts with removable covers. Where ducts are not applicable, wire bundles shall be supported by prewelded cleats or wiring rod for cable support.
- B. Solderless terminals shall be used for all secondary connections.
- C. No connections will be spliced or extended by soldering to another wire.
- D. Each lead entering or leaving the switchgear shall be brought to an approved terminal board bearing identification agreeing with the connection diagram.

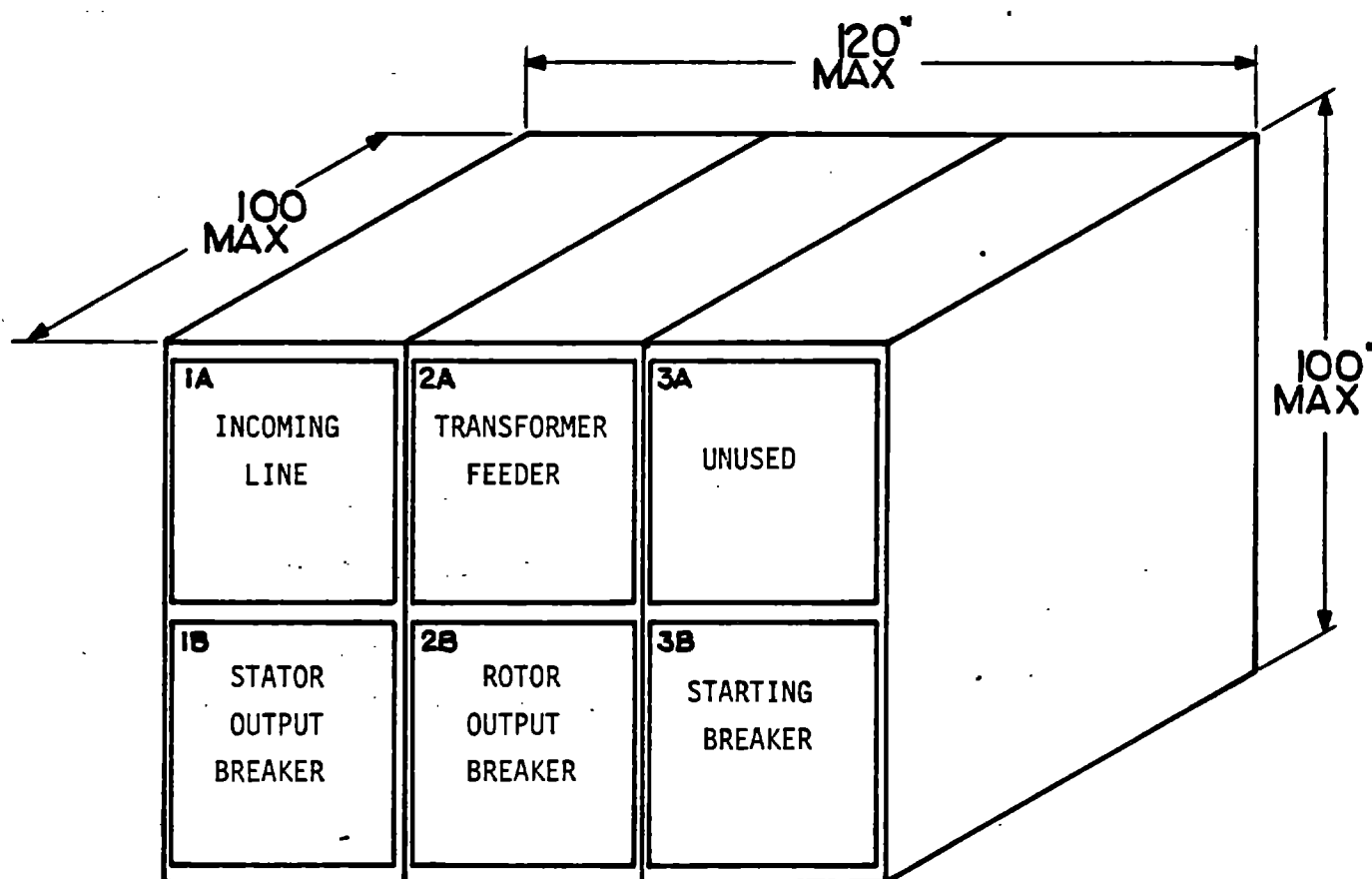
3.6.1 WIRING INTERFACE

The switchgear assembly shall provide top access for wiring. Wire terminations shall be accessible through rear covers.

3.7 ARRANGEMENT

The one-line diagram, 47E387080, shall be used in conjunction with this specification for design and selection of the switchgear equipment.

Figure 3-1 defines the suggested arrangement while Tables 3-1 through 3-6 list the major protective relays and monitoring devices required.



TYPICAL ARRANGEMENT
MOD 5A SWITCHGEAR ASSEMBLY

FIGURE 3-1

TABLE 3-1
FUNCTION - INCOMING LINE
LOCATION 1A

<u>DEVICE</u>	<u>DEVICE NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
Phase Overcurrent Relay With Voltage Restraint	50/51 V	3	IJCV51
Frequency Relay	81	1	IJF51
Phase-Sequence Relay	47	1	NVB11
Potential Transformer 4800/120	PT3	3	
Current Transformer 1500/5	CT5	3	
Lightning Arrestors 5.1 KV	--	3	
Voltage Transducer 4-20 MA Output	VT-2	3	
Current Transducer 4-20 MA Output	AT-2	3	
Kilowatt Transducer 4-20 MA Output	WT-2	1	
VAR Transducer 4-20 MA Output	VART-2	1	
Watthour Meters, (1) detented to read power output, and (1) detented to read power input, 3 element, 3 phase indicating, with pulse generators for remote accumulating.	KWH	2	
Voltmeter (4-1/2" sq) Label = Volts, Scale = 0-6000	VM	3	AB-40
Ammeter (4-1/2" sq) Label = Amperes, Scale = 0-1500	AM	3	AB-40
Kilowatt Meter (4-1/2" sq) Label = Power, Scale = -1000/0/12000	WM	1	AB-40
Kilovar Meter Label = Reactive Power Scale = -1000/0/4000	VARM	1	AB-40

TABLE 3-2
FUNCTION - STATOR OUTPUT
LOCATION 1B

<u>DEVICE</u>	<u>NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
Phase Overcurrent Relay With Voltage Restraint	50/51 V	3	IJCV51
4160 Volt Vacuum Power Circuit Breaker, 2000 Amperes Continuous, 3 Pole, With Electrically Operated, Stored Energy Mechanism	52-2	1	
Current Balance Relay	61	1	IJCS1
Lock-Out Relay	86	1	HEA61
Tripping Relay	94-2	1	HGA13
Synchronize Check Relay	25	1	GES
Overvoltage Relay	59		IAV
Differential Protective Relay	87	1	CFD22
Syncroscope Switch	SS	1	
Syncroscope	SYN	1	
Potential Transformer 4800/120	PT-2	3	
Current Transformer 1500/5	CT3 & CT4 CT3A & CT4A	12	
Frequency Transducer 4-20 MA Output	FT	1	
Voltage Transducer 4-20 MA Output	VT-1	3	
Current Transducer 4-20 MA Output	AT-1	3	
Kilowatt Transducer 4-20 MA Output	WT-1	1	
VAR Transducer 4-20 MA Output	VART-1	1	
Volt Meter (4-1/2" Sq) Label=Volts, Scale=0-6000	VM	3	AB-40

TABLE 3-2 (cont'd)
FUNCTION - STATOR OUTPUT
LOCATION 1B

<u>DEVICE</u>	<u>NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
Ammeter (4-1/2" Sq) Label=Amperes, Scale=0-1000	AM	3	AB-40
Kilowatt Meter (4-1/2" Sq) Label=Power, Scale=-1000/0/12000	WM	1	AB-40
Var Meter (4-1/2" Sq) Label=Reactive Power Scale=-1000/0/4000	VARM	1	AB-40
Frequency Meter Label=Frequency, Scale=55-65	FM	1	AB-40
Indicating Lamps, Breaker Open-Close, Red & Green	--	2	ET-16

TABLE 3-3
FUNCTION - TRANSFORMER FEEDER
LOCATION 2A

<u>DEVICE</u>	<u>DEVICE</u> <u>NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3 Phase, Fused Load Break Disconnect Switch For 300 KVA Transformer	--	1	
Indicator Lamps, Disconnect - Switch Open-Closed, Red & Green	--	2	ET-16

TABLE 3-4
FUNCTION - ROTOR OUTPUT
LOCATION 2B

<u>DEVICE</u>	<u>NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
4160 V Vacuum Power Circuit Breaker, 2000 Amperes Continuous, 3 Pole, with Electrically Operated Stored-Energy Mechanism	52-1	1	
Tripping Relay	94-1	1	HGA13
AC Time Overcurrent Relay	51	3	IAC
Current Transformer 600/5	CT8	3	
Indicating Lamps, Breaker Open-Close, Red & Green	--	2	ET-16
Current Transducer 4-20 MA Output	AT-3	3	
Ammeter (4-1/2" sq) Label = Amperes, Scale = 0-600	AM	3	AB-40

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TABLE 3-5
FUNCTION - UNUSED
LOCATION 3A

<u>DEVICE</u>	<u>DEVICE</u> <u>NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
---------------	----------------------------	-----------------	--------------------

TABLE 3-6
FUNCTION - STARTING
LOCATION 3B

<u>DEVICE</u>	<u>NO</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
4160 V Vacuum Power Circuit Breaker, 2000 Amperes Continuous, 3 Pole, with Electrically Operated Stored-Energy Mechanism	52-3	1	
Tripping Relay	94-3	1	HGA13
Current Transformer 1500/5	CT7	3	
Indicating Lamps, Breaker Open-Close, Red & Green	--	2	ET-16

3.8 LIFE

The expected lifetime of the unit shall be 30 years upon performance of the maintenance called out in section 3.9.

3.9 MAINTAINABILITY

Routine maintenance shall be able to be performed on site. Interval between routine maintenance cycles shall not be less than one (1) year. Supplier shall identify required maintenance of major components.

SECTION 4.0 VERIFICATION

4.1 GENERAL

The vendor shall perform standard commercial tests to demonstrate proper operation of the switchgear assembly. Three (3) certified copies of actual test data shall be provided with shipment. Tests shall include, but not be limited to the following.

4.2 INSPECTION

4.2.1 TRANSFORMERS

Polarity and ratio check of all transformers.

4.2.2 INSTRUMENTS

All relays, instruments and other devices shall be checked for internal or concealed shipping damage.

4.2.3 WIRING

All wiring shall be checked for loose connections.

4.2.4 FINISH

Visual inspection to verify that finish coating is applied to all surfaces.

4.3 FUNCTIONAL TEST

4.3.1 CONTINUITY

Continuity check of all wiring to elementary diagram.

4.3.2 CIRCUIT BREAKERS

Circuit breakers shall be checked for operation at 80, 100, and 110 percent of normal operating voltages, open and closed circuits. Also opening, closing and trip free times of the circuit breakers (52-1, 52-2, 52-3) at normal operating voltages shall be checked. Average and range of ten (10) tests after all adjustments have been made shall also be recorded.

4.3.3 PRIMARY CIRCUITS

An insulation test of all 4 KV circuits shall be performed. The test voltage shall be 19 KV, AC, R.M.S., 60 Hz and shall be applied for a minimum of one (1) minute between each circuit and all other circuits and ground. No flashover or insulation puncture shall occur.

4.3.4 SECONDARY CIRCUITS

An insulation check of all secondary and control circuits shall be performed. The test voltage shall be 1.5 KV, AC, R.M.S., 60 Hz and shall be applied for a minimum of one (1) minute between each circuit and all other circuits and ground. No flashover or insulation puncture shall occur.

SECTION 5.0
DOCUMENTATION

5.1 APPROVAL

Upon award of a contract, the vendor shall furnish drawings (2 sets) for approval prior to manufacturing. Drawings for approval shall include a plan view, outline drawings, and an elementary diagram. Comments or approvals will be returned within two (2) weeks of receipt.

5.2 DELIVERABLE

The following documents shall be supplied with shipment.

- o Certified outline drawing
- o Wiring diagrams
- o Elementary diagrams
- o Complete instruction books with parts lists
- o Detailed summary or equipment list
- o Schematics
- o Test data
- o Operational and maintenance manual for all equipment

One regular reproducible and ten (10) copies of drawings, twelve (12) copies of instruction books, and three (3) copies of test data shall be supplied. In addition, one copy of all documents shall be enclosed with shipment.

SECTION 6.0
PREPARATION FOR DELIVERY

The vendor shall submit a statement detailing his normal practice of packaging and method of delivery for approval by the General Electric Company, Advanced Energy Programs Department, MOD-5A WTG Engineering, 501 Allendale Road, P.O. Box 527, King of Prussia, PA 19406.

47A380101

CONT ON SHEET *ii*

SH NO *i*

REV NO.
47A380101
CONT ON SHEET <i>77</i> SH NO. <i>7</i>

TITLE

FIRST MADE FOR

TEST PLAN
FOR THE
MOD-5A FLAP DEVELOPMENT
WIND TUNNEL PROGRAM
MAY 1983

REVISION

ISSUED REV "A" *May 1983*
PER AN-1
ISSUED REV "B" *May 1983*

Russell Feldman
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DATE: *May 6, 1983*

Al Bonta
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DATE: *5/9/83*

TOTAL NUMBER OF PAGES *19*

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WTG
500
PRINTS 1

MADE BY	APPROVALS	DIV OR DEPT.	47A380101
ISSUED <i>W. B. Bonta</i> <i>5/10/83</i>	<i>A.E.P.</i>	KING OF PRUSSIA, PA. LOCATION	CONT ON SHEET <i>ii</i> SH NO. <i>i</i>

REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

Revision	Page No.	Paragraph Number(s) Affected	Rev. Date	Approval
A		General Revision to delete Kulite test and add VF (ventilated flap) test	5/19/83	
B	2	2.2.1, 2.2.2.3	6/27/83	
	3	2.2.2.5		
	5	Table I		
	8	Table III		
	13	Figure 3		
	15	Figure 5 (deleted)		
C	7	Table IIB completed	10/4/83	

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2.2.2.3 Model BF-P1(Perforated Balance)	2
2.2.2.4 Model SBF (Short Balance Flap)	3
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2.2.2.6 Model VF (Ventilated Flap)	3
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1.0 INTRODUCTION

1.1 SCOPE

This test plan defines the test program to be performed by Ohio State University Aeronautical and Astronautical Research Lab (OSU/AARL) and to be used to develop an optimum aerodynamic control flap configuration for the MOD-5A wind turbine for General Electric Co.'s Advanced Energy Programs Department (GE/AEPD).

1.2 OBJECTIVES

This wind tunnel program is intended to provide an optimum flap configuration and its associated aerodynamic characteristics, as a basis for a decision on the use of flap controls.

2. TEST FACILITIES

The tests will be carried out in the OSU/AARL transonic airfoil facility designated as the 6" x 12" wind tunnel.

2.1 INSTRUMENTATION

The instrumentation required to acquire the data needed to provide the aerodynamic characteristics of the models will be provided by OSU/AARL.

2.2 MODELS

2.2.1 GENERAL

There will be seven (7) test models in the program.

2.2.2 GEOMETRIC DEFINITION

The geometric definition of the test models will be provided by GE AEPD.

2.2.2.1 Model BFØ (Basic Balanced Flap)

This model, which is defined in Figure 1, exists.

2.2.2.2 Model PF (Plain Flap)

This model exists and is defined in Figure 2.

2.2.2.3 Model BF-P1 (Perforated Balance)

This model is defined in Figure 3 revised June 21, 1983. A dedicated flap (only) model will be fabricated for this test.

2.2.2.4 Model SBF (Short Balance Flap)

This configuration is defined in Figure 4 and requires the rework of the configuration BFØ flap.

2.2.2.5 Models BF-LE1; BF-LE2 (Flap Model with Modified Leading Edges)

Deleted

2.2.2.6 Model VF (Ventilated Flap)

This configuration is defined in Figure 6. The ventilation pattern described in that figure will be a rework of either configuration BFØ, or PF. The selection will be made on the basis of test results. This model requires the fabrication of a spare BFØ flap (only) model.

2.2.2.7 Models X1 and X2

These models will be specified by July 25, 1983 for testing in the period from August 8 to August 12, 1983.

2.2.3 DESIGN AND FABRICATION

The detail design and fabrication of the models will be the responsibility of OSU/AARL.

3.0 TEST PLAN MATRIX

3.1 GENERAL

Ten (10) model configurations will be tested through a 24 point array of angles of attack and control deflection. These tests will be conducted at Reynolds numbers not less than 8×10^6 . The tests will measure steady pressure distributions with the standard Scanivalve instrumentation of OSU/AARL. At the conclusion of these Phase I tests there will be a one month period during which two final models will be defined, designed and fabricated. These final models will be tested in the Phase II tests.

3.2 TEST MATRIX

The test matrix is defined in Tables I and IIA and IIB. Table I describes the matrix of tests to be made. Table IIA and IIB describe the combinations of angles of attack and control deflection angles for the screening tests and the final tests respectively.

3.3 SCHEDULE

The program shall conform to the schedule in Table III.

TABLE I
 MATRIX OF TESTS

Seq. No.	Model Configuration	Figure No.	α/δ^4 Array	Purpose
1	PF	2	Basic	Basic aerodynamic characteristics of plain flap
2	BFØ	1	"	Basic aerodynamic characteristics of balanced flap
3	BF-P1 ¹	3	"	Effect on balanced flap of porosity of balance
4	SBF ²	4	"	Characteristics of short balanced chord
5	VF ³	6	"	Effect of ventilating flap

TIME SLOT FOR DESIGN AND FABRICATION OF OPTIMUM CONFIGURATION.

6	X1	Detailed	Basic aerodynamic characteristics of MOD-5A flap at 70% radius
7	X2	"	Basic aerodynamic characteristics of MOD-5A flap at 85% radius

NOTES

- ¹ Requires new (untapped) flap only model.
- ² Requires rework of existing (tapped) flap.
- ³ Model BFØ or PF to be reworked, requires fabrication of untapped BFØ model.
- ⁴ The "Basic" and "Detailed" combinations of angle of attack and control deflection are given in Tables IIA & IIB.

TABLE IIA
 BASIC ARRAY OF ANGLES-OF-ATTACK AND CONTROL DEFLECTION ANGLES
 (24 RUNS)

$\delta^\circ \downarrow$ $\alpha^\circ \rightarrow$	<u>3</u>	<u>6</u>	<u>9</u>	<u>12</u>	<u>15</u>	<u>18</u>	<u>21</u>	<u>24</u>
0	x	x	x					
-3	x	x	x					
-6	x	x	x					
-9				x				
-15					x	x	x	x
-30					x	x	x	x
-60						x	x	x
-90						x	x	x

TABLE IIB

ARRAY OF DETAILED ANGLES-OF-ATTACK AND CONTROL DEFLECTION ANGLES
 (32 RUNS)

$\delta^\circ \downarrow \alpha^\circ \rightarrow$	3	6	9	12	15	18	21	24	27	30	33
0		X	X	X							
-5			X	X	X						
-10			X	X	X						
-15			X	X	X	X					
-30			X	X	X	X					
-45					X	X	X				
-75						X	X	X	X	X	X
-90						X	X	X	X	X	X

TABLE III
 MOD-5A FLAP DEVELOPMENT TEST PLAN
 SCHEDULE

	June	July	Aug.	Sept.
Basic W/T Program				
Design of Optimum Configuration				
Fabricate Configuration				
Test Optimum Configuration				

4.0 SUPPORT REQUIREMENTS

4.1 LIAISON

GE/AEPD will provide a liaison engineer to coordinate this test and to be present at OSU/AARL during the test program.

5.0 DELIVERABLES/SCHEDULE

5.1 DATA DELIVERABLES

OSU/AL will provide "real time" data of test results for evaluation of day-to-day progress in both tabular and graphic form as tests are complete. In addition, a FORTRAN readable tape of all of the reduced data will be provided.

5.2 REPORT DELIVERABLES

OSU/AL will provide six (6) copies of a final report summarizing the program not later than September 3, 1983.

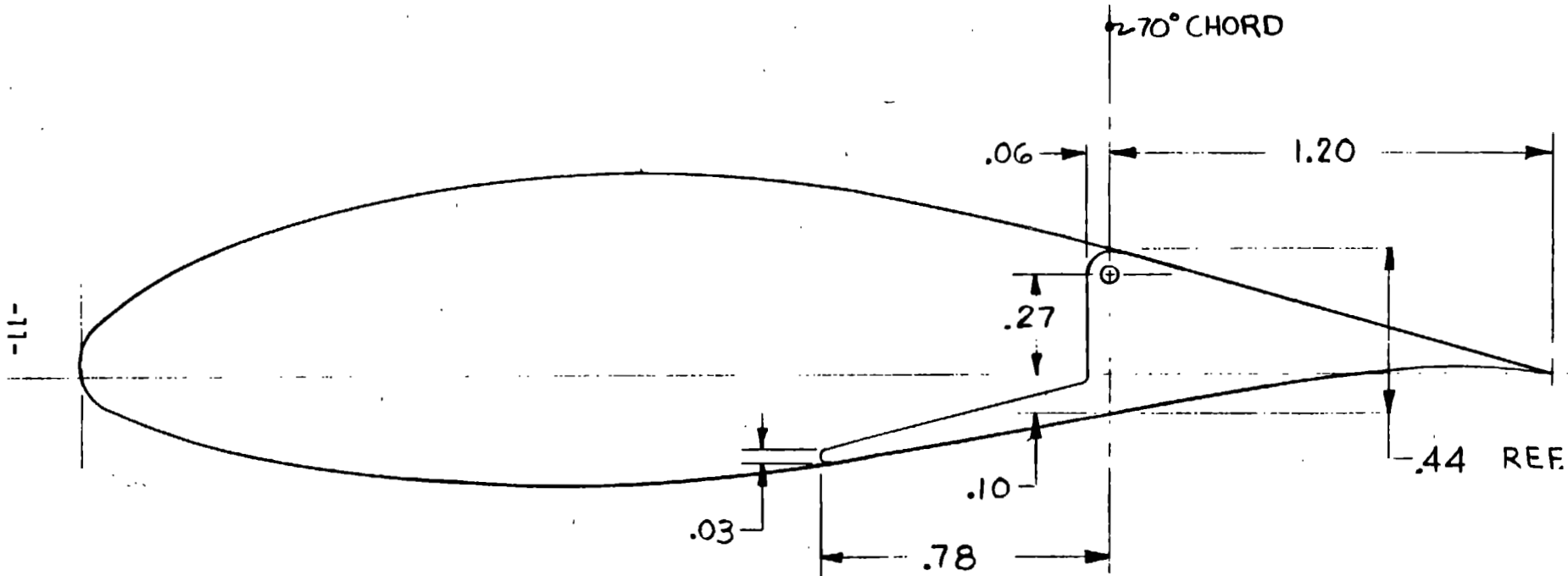
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REVISIONS

ZONE	LTR	DESCRIPTION	DATE	A
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MOD-5A WTG
FLAP DEVELOPMENT
WIND TUNNEL PROGRAM
TEST PLAN
47A380101
SEPT., 1983
REV. C

ORIGINAL PAGE 3
OF POOR QUALITY

CHORD = 4.00"

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES ON:FRACTIONS DECIMALS ANGLES
± ± ±

ALL SURFACES ✓

MATL.

SIGNATURES

DRAWN *[Signature]* DAY MO YR

CHECKED

ISSUED

ENGRG

MTG

MATLS

GENERAL ELECTRIC
AEP DEPT LOC. KING OF PRUSSIA

MODEL BFØ

SIZE

B

CODE IDENT NO.

FIG. 1

SCALE

SHEET

5

4

FOLD

3

2

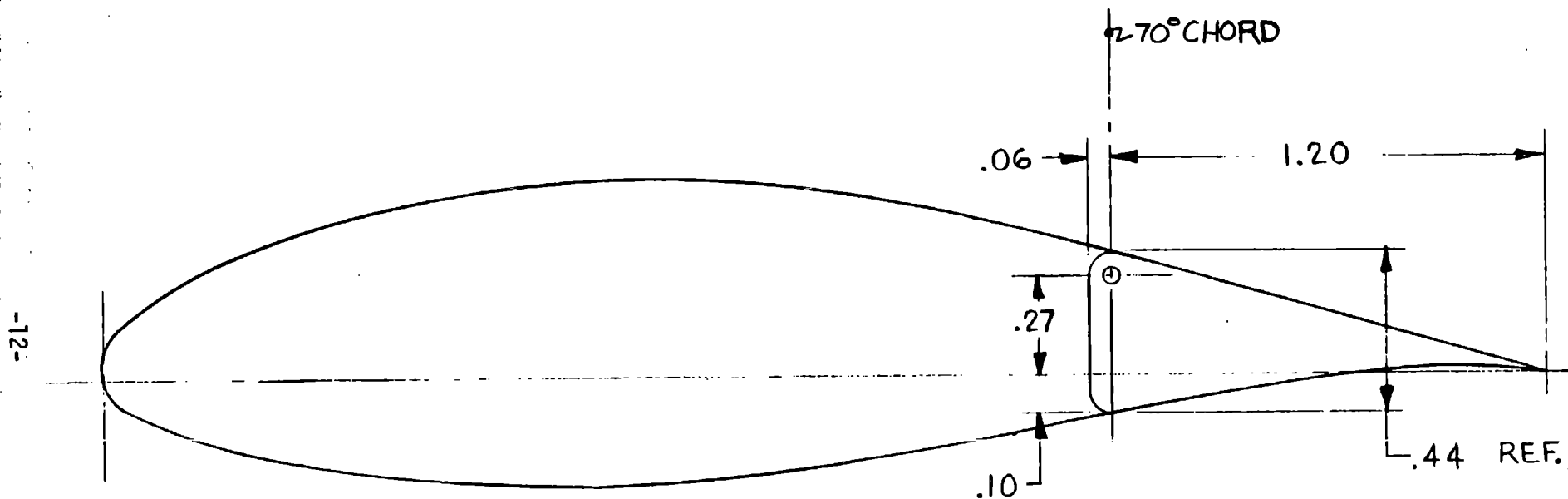
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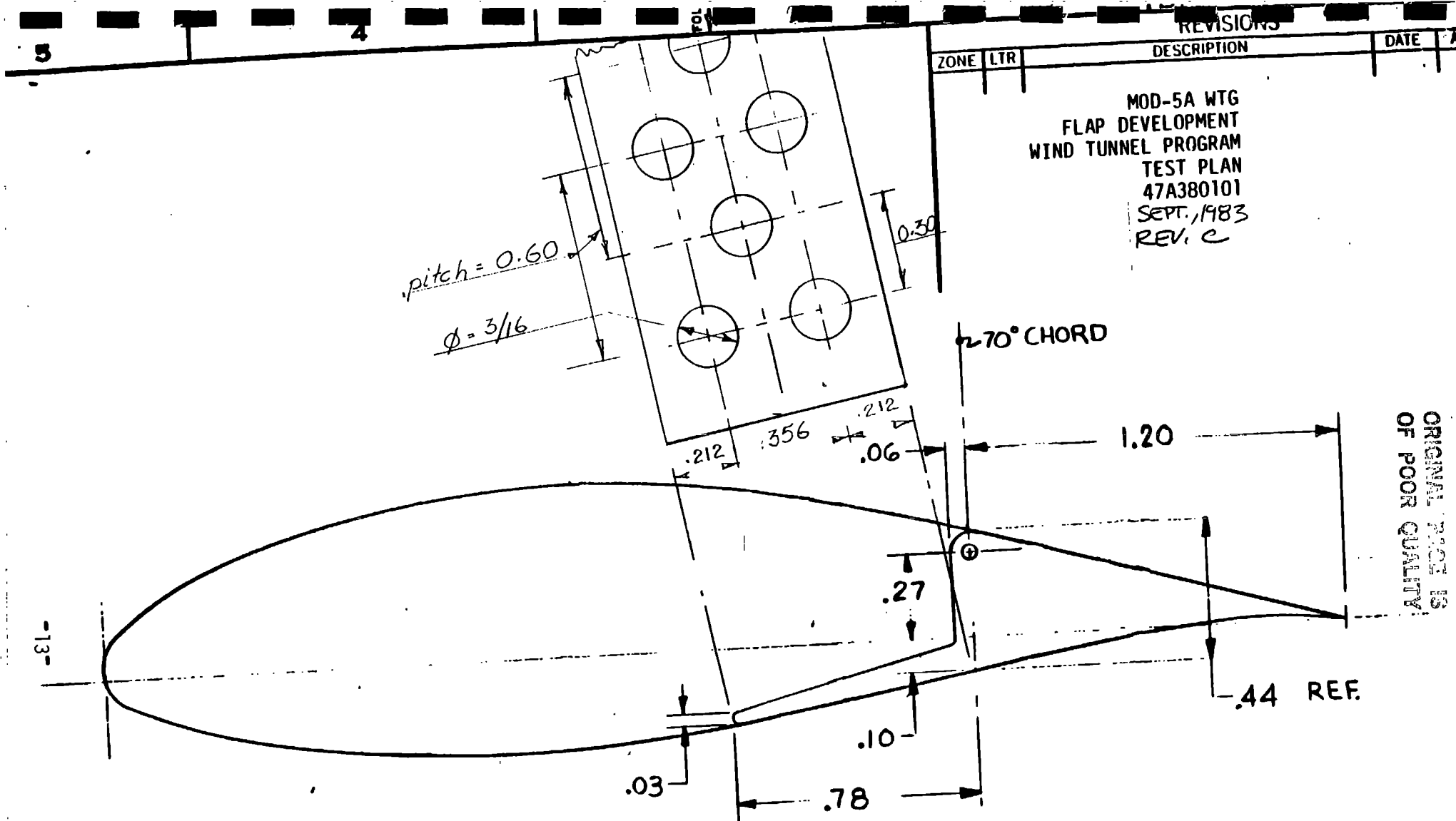
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TEST PLAN
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REV. C



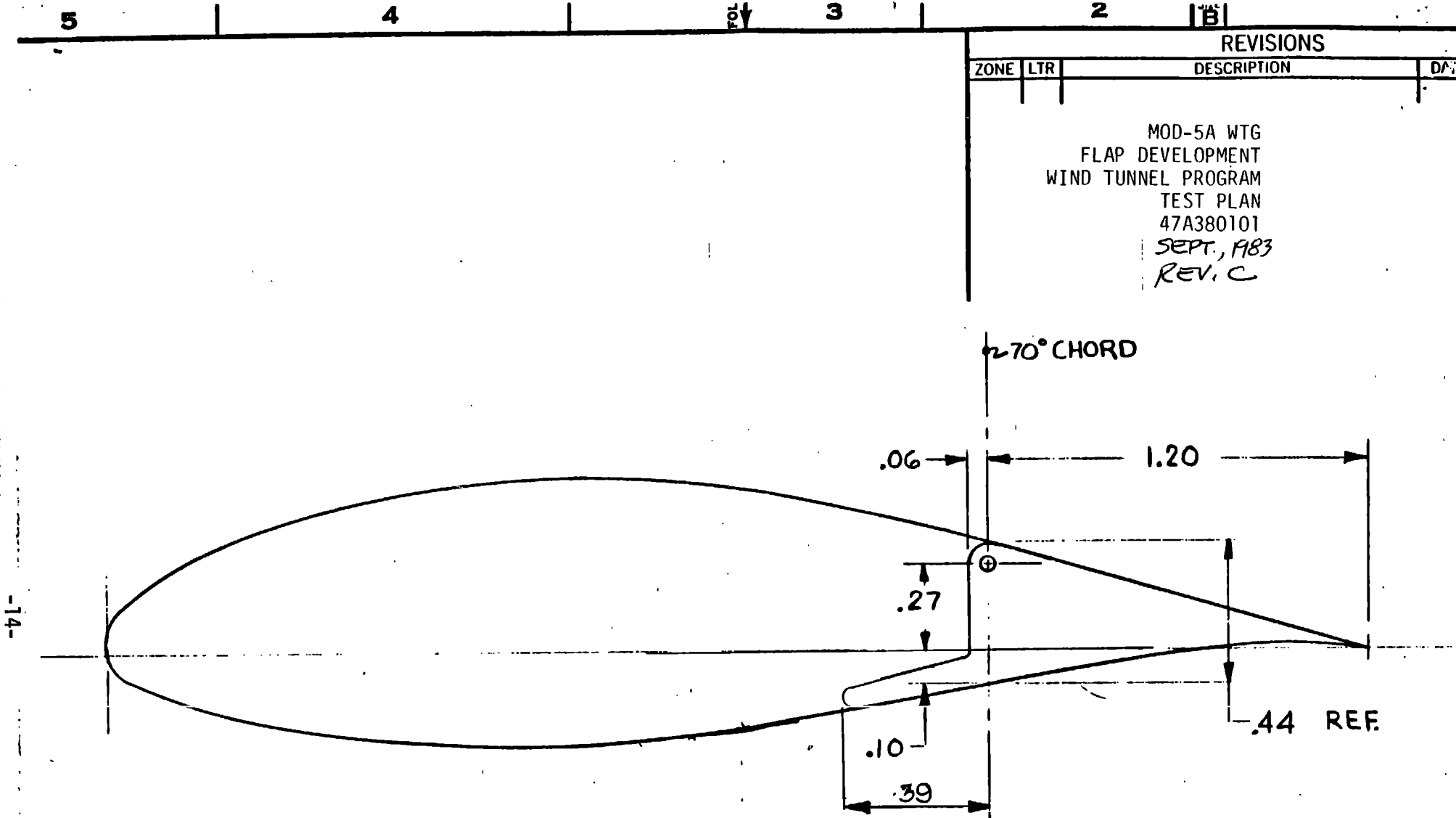
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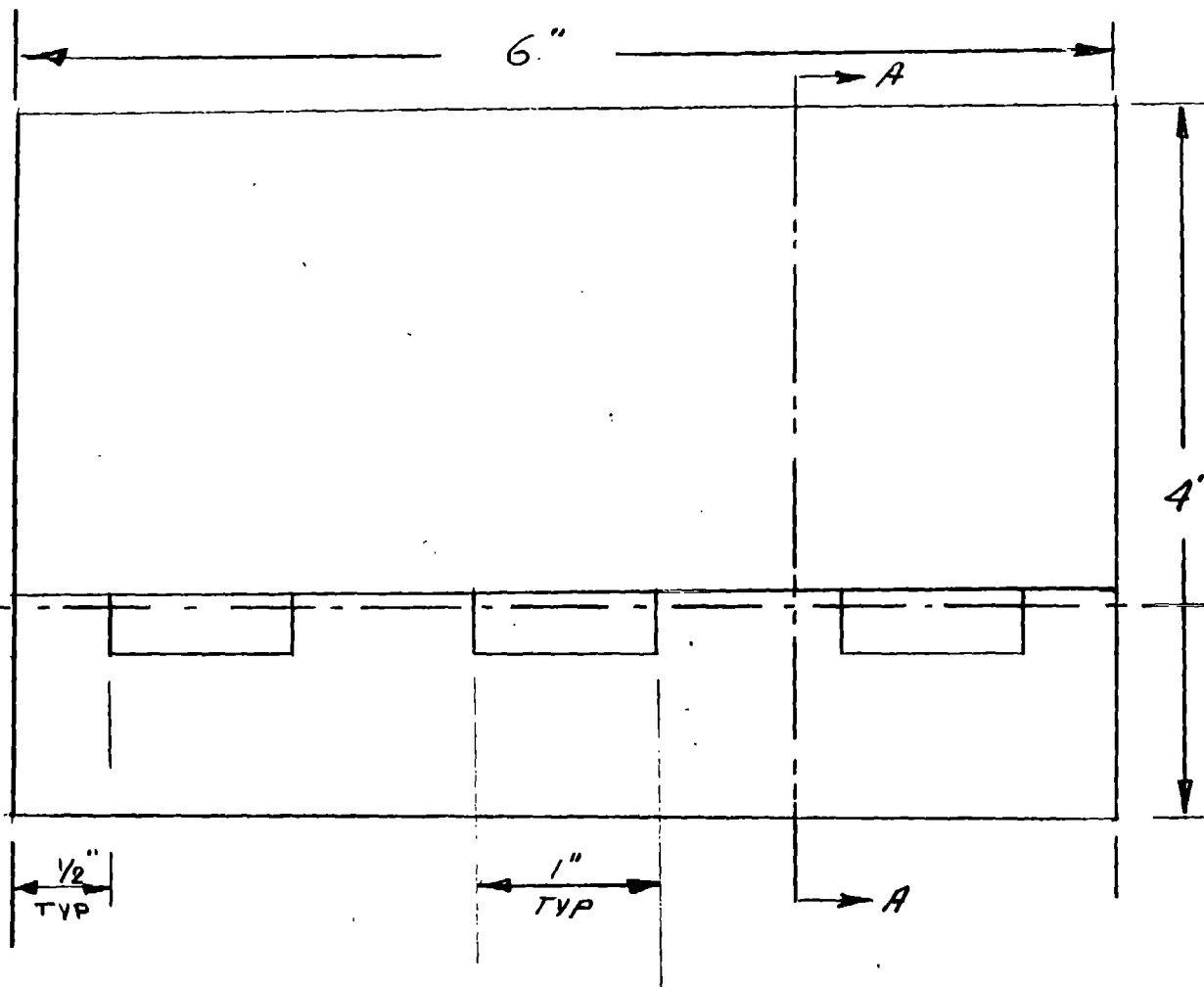
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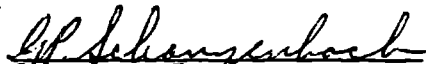
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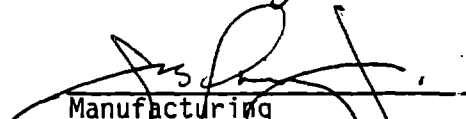
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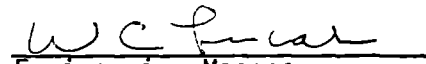
FINISH SPECIFICATION FOR ALUMINUM
ALLOYS USED FOR ELECTRICAL AND
RELATED EQUIPMENT FOR THE
MOD-5A WIND TURBINE GENERATOR
JULY 1983


Responsible Engineer DATE: 7-25-83


Subsystem Engineer DATE: 7-25-83


Manufacturing DATE: 8/26/83



Quality Assurance DATE: 8-3-83


Engineering Manager DATE: 9/7/83

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REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

Revision	Page No.	Paragraph Numbers(s) Affected	Rev. Date	Approval
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1.0 GENERAL

This document defines the material and application of a semi-gloss Enamel finish applied to Aluminum parts for Electrical and Systems Test Equipment.

2.0 APPLICABLE DOCUMENTS

Specifications:

Federal

TT-E-529 Enamel, Synthetic-Semi-Gloss

TT-P-1757 Chemical Films for Aluminum and Aluminum Alloys

Military

MIL-C-5541 Chemical Conversion Coatings on Aluminum and Aluminum Alloys

MIL-P-6808 Primer Coating, Zinc Chromate, for Aircraft Use, Application of

Standards:

Federal

FED-STD-595 Colors

3.0 MATERIAL

Enamel Synthetic -- semi-gloss, conforming to Federal Specification TT-E-529.

Color shall be in accordance with FED-STD-595. Individual colors are specified in Table I.

TABLE I

<u>GE PART NO.</u>	<u>COLOR</u>	<u>COLOR NO.</u>	<u>GLOSS</u>
P1	Blue	25550	Semigloss
P2	White	27875	Semigloss
P3	Blue	25102	Semigloss
P4	Gray	26492	Semigloss

4.0 APPLICATION

All surfaces to be painted shall be dry, clean and free from moisture, dirt, grease or other contaminants.

- o Preliminary treatment shall be applied in accordance with MIL-C-5541, Class 1.
- o Prime material to be painted with zinc chromate primer conforming to TT-P-1757 in accordance with MIL-P-6808.
- o Apply Enamel (Paragraph 2.0) as follows:
 - 1 Coat, 1.0 to 1.5 mils thick.

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<u>R. E. Hoppus</u>		DATE: <u>11/15/83</u>		
Responsible Engineer				
<u>R. B. [Signature]</u>		DATE: <u>11/15/83</u>		
Systems Engineering				
<u>R. R. Laessig</u>		DATE: <u>11/15/83</u>		
Chief Engineer				
<u>A. Cheddi</u>		DATE: <u>1-6-84</u>		
Quality Assurance				
<u>W. C. Pijou</u>		DATE: <u>1/6/84</u>		
Program Manager				
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1.0 INTRODUCTION

1.1 SCOPE

This test plan defines the MOD-0/5A test to be performed by GE and NASA-LeRC. A vendor, Schweizer Aircraft Corp., will design, fabricate and proof test the Test Units to be used for evaluation and demonstration of the aerodynamic control aileron configuration for the MOD-5A wind turbine for General Electric Co.'s Advanced Energy Programs Department (GE/AEPD). The Test Unit will be a sub-scale version of the MOD-5A aileron design, suitable for test operation on the existing NASA MOD-0 test bed WTG at Plum Brook.

1.2 GENERAL OBJECTIVES

This larger physical scale aileron test in a rotational environment is intended, in conjunction with the ongoing wind-tunnel data acquisition, to provide sufficient performance data on the selected configuration and its associated aerodynamic characteristics, as a basis for a decision on the use of aileron controls for the MOD-5A WTG. If a decision is confirmed to change the MOD-5A baseline to aileron rather than PSC control, it must be based on adequate test data to insure a high probability of success.

More specifically, the MOD 0/5A test is intended to provide a limited demonstration of the ability of an aileron system to meet the major aerodynamic control requirements of an aileron system for MOD-5A rotor torque control. Two major performance requirements exist: 1) Production of sufficient negative torque to slow the rotor to a safe speed (both undamaged and with partial jam) under both controlled and emergency shutdown conditions

and, 2) Provide characteristics of torque vs. control deflection suitable to provide stable control/regulation operation for torques from at least 10% above rating to at least 10% negative torque over an appropriate range of operating rotor speeds and windspeeds.

The test objectives are to demonstrate the capability of ailerons to meet the two major aerodynamic requirements, and to acquire data on primary performance characteristics, secondary control characteristics and environmental performance characteristics, which can be correlated with predictions based on wind tunnel data and other analyses.

2.0 MOD-0/5A TEST REQUIREMENTS AND ACCEPTANCE CRITERIA

2.1 SHUTDOWN DEMONSTRATION

2.1.1 Basic Shutdown Demonstration

With all aileron control surfaces operating, a loss-of-load (emergency) shutdown shall result in no more than 20% of maximum operating rpm overspeed and reach an equilibrium velocity ratio (λ) of no more than 1.5. Control rates of 25, 15, and 5 degrees per second shall be evaluated to confirm the rate necessary to meet the overspeed limit. Final control surface positions of -45, -60, -75, and -95 degrees shall be evaluated to determine the position necessary to meet the velocity ratio limit. Initial wind speeds shall be in three ranges for low ($6 < \lambda$), moderate ($4 < \lambda < 6$), and high ($\lambda < 4$) conditions. Initial loads shall be for least three values from 0 to 100% of rating.

Normal (controlled) shutdowns shall also be demonstrated at low and moderate wind conditions where the load is reduced to zero at a controlled (non-emergency) rate, and a feather rate of 5 degrees per second is employed.

Acceptance Criteria:

- a) Overspeed for emergency shutdown of less than 4 rpm @ 20 rpm initially (20% of 20 rpm)
- b) Stable control characteristics for normal shutdowns
- c) Equilibrium speed (rpm) less than $0.33 * V_W(\text{mph})$ ($\lambda = 4.57 \text{ N}/V_W$ and $\lambda_E = 1.5$)

Data:

- a) Standard measurement set (see Section 3.1)
- b) Control rate limit recommendation
- c) Final control surface position recommendation

2.1.2 Partial Damage Shutdown Demonstration

With a minimum of 20% of the effective aileron control surface restrained in maximum rotor torque position (unfeathered), to simulate a jammed or damaged condition, a loss-of-load shutdown shall result in no more than 20% of maximum operating rpm overspeed and reach an equilibrium velocity ratio of no more than 2.0. Sufficient control rate, final control position, wind speed, and initial load configurations shall be selected from the values in Section 2.1.1 to demonstrate the overspeed and equilibrium requirements. A normal shutdown with a "damaged" aileron shall also be demonstrated as in 2.1.1.

Acceptance Criteria:

- a) Overspeed for emergency shutdown of less than 4 rpm (20% of 20 rpm)
- b) Stable control characteristics for normal shutdowns
- c) Equilibrium speed (rpm) less than $0.44 * V_W(\text{mph})$ ($\lambda_E \approx 2.0$)

Data:

- a) Standard measurement set
 - b) Control rate limit recommendation
 - c) Final control surface position recommendation
- } With damaged
aileron

2.2 STABLE REGULATION CONTROL DEMONSTRATION

2.2.1 Speed Regulation

Rotor speed shall be stable and within $\pm 5\%$ of maximum operating speed around the speed reference. A speed regulating feedback control loop with proportional plus integral capability shall be utilized with stable gain settings that use the aileron surface position as the final control element. Control rate limits of 2 and 5 degrees per second shall be evaluated. Sufficient wind speed ranges shall be selected from the values in Section 2.1.1 to demonstrate the regulation band.

Acceptance Criteria:

- a) Stable behavior
- b) Speed regulation within ± 1 rpm ($\pm 5\%$ of 20 rpm)

Data:

- a) Standard measurement set
- b) Control rate limit recommendation

2.2.2 Power Regulation

Output power shall be stable and within ± 20 kw around the power reference when in an active regulating mode. A power regulating feedback control loop with proportional plus integral capability shall be used with stable gain settings that use the aileron surface position as the final control element. Control rate limits of 2 and 5 degrees per second shall be evaluated. Sufficient wind speed ranges shall be selected from the values in Section 2.1.1 to demonstrate the regulation band. Power reference values shall be selected to force operation in an active regulating mode for each wind speed range.

Acceptance criteria:

- a) Stable behavior
- b) Power regulation within ± 20 kw

Data:

- a) Standard measurement set
- b) Control rate limit recommendation

2.3 SOUND LEVEL DEMONSTRATION

Average dBA (A-scale weighted) sound levels shall be no more than 3dBA higher than comparable measurements on a tip controlled, similarly configured MOD-0. Measurements shall be recorded for near (120-150ft) and far (800-1000 ft or limit of audibility) field locations both down wind and in the plane of the rotor. Data shall be acquired on rotor positions and control deflection coincident with sound measurements and analysis shall be performed to

differentiate the effect of tower shadow and control deflection. Broad band measurements from 5 to 20,000 Hertz shall be recorded as appropriate for database creation and spectral analysis.

Acceptance criteria:

- a) Average dBA levels less than 3dBA above tip controlled configuration in power control and speed control modes
- b) Acquisition of basic sound level data on MOD-0/5A configuration

Data:

- a) Standard measurement set plus sound instrumentation
- b) Sound recordings in various winds in speed control
- c) Sound recordings in various winds in power control
- d) Sound recordings in various winds during selected shutdowns
- e) Spectral narrow band and 1/3 octave analysis of items b) through d) for representative conditions
- f) Qualitative assessment of sound by experienced site operators

2.4 SECONDARY EFFECT DEMONSTRATION

2.4.1 Stability

The test unit shall exhibit no aerodynamic instability during any speed control, power control, shutdown, or startup operating mode. Aileron hinge line mass balancing may be used to avoid instability.

Acceptance Criteria:

- a) No aerodynamic instability as indicated by control position or strain measurements

Data:

- a) Standard measurement set
- b) Mass balance weight and location, if any

2.4.2 Self-Feathering

The test unit aileron shall move to a retarding torque position on loss of control power. Aerodynamic, centrifugal, or stored energy forces shall cause smooth stable motion. Demonstration of stored energy effect shall be made without rotation.

Acceptance criteria:

- a) Non-rotating motion to feather on removal of control power
- b) Operation of hydraulic control bypass to demonstrate centrifugal plus aerodynamic forces sufficient to drive aileron to approximately 60° feather or greater.
- c) Aileron hinge torque or control rod strain versus position at speed to demonstrate aerodynamic forces sufficient to drive aileron to feather

Data:

- a) Standard measurement set
- b) Control deflection with zero control power

2.5 DATA REQUIREMENTS

2.5.1 Standard Test Data Set

The standard test data set consists of system parameter and strain measurements identified in Section 3.1 of this plan. The standard data set shall be recorded in either analog or digital format for reduction and analysis. Requirements for sound level data, including desired outputs are described in Section 2.3

2.5.2 Standard Data Reduction

1) On-Site Data Reduction

Data will be monitored and evaluated in real time (or near real time) using the standard Plum Brook MOD-0 data recording/analysis techniques. Limited statistical processing will be accomplished utilizing standard NASA software on the on-site mini-computer. Decisions regarding changes in configuration, adequacy of acquired data to meet matrix requirements, etc. will be based on evaluation of on-site data, outputs and comparison with pretest predictions.

2) Post-Test Data Reduction

Statistical processing of the data noted in Section 2.5.1 shall consist of the NASA standard separation into mean and cyclic components per rotor cycle plus distribution versus windspeed and cumulative occurrence in plot and tabular form.

2.5.3 Special Data Reduction

It is desirable to attempt computation of the effective aerodynamic characteristics of the aileron control section by means of quasi-instantaneous or bins analysis of the standard data set. Data reduction and analysis of more complexity than the standard package are necessary.

1) Wind Speed Time Shift and Angle of Attack

A time shifted wind speed has been found to better correlate with machine measurements than raw data from the physically separated reference anemometer. Wind speed measurements shall be time shifted by the separation distance divided by the wind speed measurement. The shifted wind speed shall be used with rotor speed to compute the apparent angle-of-attack (α) at the blade.

2) Aerodynamic Property Analysis

Compute aerodynamic properties of ailerons lift and drag increments of a representative aileron section in consistent units by:

- a) Determine MC1, blade root aerodynamic chordwise bending from power and speed or from strain readings with the blade vertical or average horizontal.
- b) Determine MC2, blade control span aerodynamic chordwise bending from strain reading at the inboard end of the control span (i.e., inboard end of aileron test unit) with the blade vertical or average horizontal.
- c) Determine MF1, blade root aerodynamic flapwise bending from strain readings.
- d) Determine MF2, blade control span aerodynamic flapwise bending from strain readings.

e) Sort the data from a) through d) by angle of attack (α) computed in 1.) above and control deflection (δ) bins.

f) Determine incremental values in each angle-of-attack bin by subtracting the zero control deflection value from non-zero control deflection values. i.e.:

$$DMC1 (\delta) = MC1 (\delta) - MC1 (0)$$

$$DMC2 (\delta) = MC2 (\delta) - MC2 (0)$$

$$DMF1 (\delta) = MF1 (\delta) - MF1 (0)$$

$$DMF2 (\delta) = MF2 (\delta) - MF2 (0)$$

g) Compute representative chord force and location in each angle of attack (α) bin from separation in chord bending measurements (cx) and data from f)

$$FC (\delta) = [DMC1 (\delta) - DMC2 (\delta)] / cx$$

$$XC (\delta) = DMC2 (\delta) / FC$$

h) Compute representative flap force and location in each angle of attack bin from separation in flap bending measurements (fx) and data from f).

$$FF (\delta) = [DMF1 (\delta) - DMF2 (\delta)] / fx$$

$$XF (\delta) = DMF2 (\delta) / FF$$

i) Rotate through apparent angle of attack to develop lift and drag forces

$$FL (\delta) = FF (\delta) \cos (\alpha) + FC (\delta) \sin (\alpha)$$

$$FD (\delta) = FF (\delta) \sin (\alpha) - FC (\delta) \cos (\alpha)$$

(Assumes + FC towards leading edge)

3.0 TEST FACILITIES

The tests will be carried out at the NASA-LeRC Plum Brook facility using the MOD-0 machine. The GE aileron test articles will be mounted to the ends of the existing NASA 40 ft inner blade stubs. A similar test arrangement was employed by NASA for their own earlier aileron control tip testing.

3.1 INSTRUMENTATION

The instrumentation required to acquire the data needed to evaluate aileron tip control characteristics of the test unit will be provided by NASA-LeRC. The standard measurement set will provide means to measure the following parameters:

- o Rotor Speed/Position
- o Upwind Wind Speed/Direction (corrected for transport lag
sensor-to-rotor)
- o Power Output
- o Shaft Torque
- o Nacelle Yaw/Direction
- o Aileron Positions - Both Blades (2 transducers)
- o Aileron Pushrod Loads - Both Blades (4 prime, 4 back-up)
- o Chordwise Bending Moments } Both Blades, Near Hub
- o Flapwise Bending Moments }
- o Chordwise Bending Moment } Both Blades, Near Sta 500
- o Flapwise Bending Moment } (4 prime, 4 back-up)

In addition to the standard measurement set, instrumentation will be provided for evaluation of sound levels during part of the testing (regulation tests and a limited number of selected shutdown tests):

- o Sound Pressure Levels

- Distance of one (1) rotor diameter (rotor plane and downwind)
- Distance of five (5) to ten (10) rotor diameters
(rotor plane and downwind)

Onsite data reduction/evaluation will employ the Plum Brook real-time data systems and mini-computer system with existing software for rapid on-site analysis of data.

Data will be recorded on standard NASA-LeRC analog and digital tapes for possible post test analysis and diagnostics. Sound levels may be recorded on a different recorder but shall be keyed to a common time-base system for correlation of events in data analysis.

3.2 TEST UNIT

3.2.1 General

The test units will consist of two aileron-equipped tip sections to be attached to the outer ends of the existing NASA 40 ft wooden stub blades of the Plum Brook MOD-0 machine. The test units will provide for in-air change over to two (2) basic aileron configurations in either "undamaged" or "damaged" condition. Additional configuration changes can be accomplished by removing the aileron surfaces for on-ground modifications. The test unit overall size, planform and actuation system will be similar to the NASA aileron blade control test units used in earlier experiments on the MOD-0 machine. The basic airfoil section, however, will be that of the GE MOD-5A WTG rotor (NASA 64XXX).

A minimum of two (2) basic aileron configurations will be available for test:

- Basic Plain Aileron
- Basic Balanced Aileron

These will each be field-convertible to vented configurations so that a maximum of four (4) configurations can be evaluated in the Phase I MOD-0/5A tests, depending upon results of the wind-tunnel test program now in progress and initial MOD-0/5A test results. All configurations will be hinged at 62% chord on the low pressure side of the airfoil. Balanced aileron configurations will extend to the 50% chordline on the high pressure side of the airfoil. All configurations will be comprised of several sections per blade so that a jammed control situation can also be simulated with in-air changes.

3.2.2 Geometric Definition

The geometric definition of the test unit is provided by GE. The overall layout of the test unit showing the planform and general arrangement of the aileron is shown in GE Drawing No. 47J382316 and Figure 1. The unvented, plain and balanced aileron configurations are shown to illustrate the general method of attachment to the trailing edge of the test unit, the hinge location, and the method of segmenting (six segments per blade in final design) the aileron for ease in in-air handling and change over of test configuration. The aileron segments can be locked together in the combinations shown on Figure 1.

More detailed definition of the various available test aileron configurations for Phase I is given in Figures 2-4. Details of the basic plain aileron are shown in Figure 2. This configuration is a typical unslotted, unvented, 38%

POSSIBLE AILERON SECTION COMBINATIONS

MOD-0/5A AILERON DEVELOPMENT
TEST PROGRAM
TEST PLAN 47A380107
NOVEMBER 1983

UNIT VARIABLE		UNIT AT FIXED δ
1)	ALL (1-6)	--
2)	1, 2, 3	4, 5, 6
3)	4, 5, 6	1, 2, 3
4)	1, 2	3, 4, 5, 6
5)	3, 4, 5, 6	1, 2

(NOTE: HYDRAULIC TRAVEL $\Delta \delta = 100^\circ$ MAX)

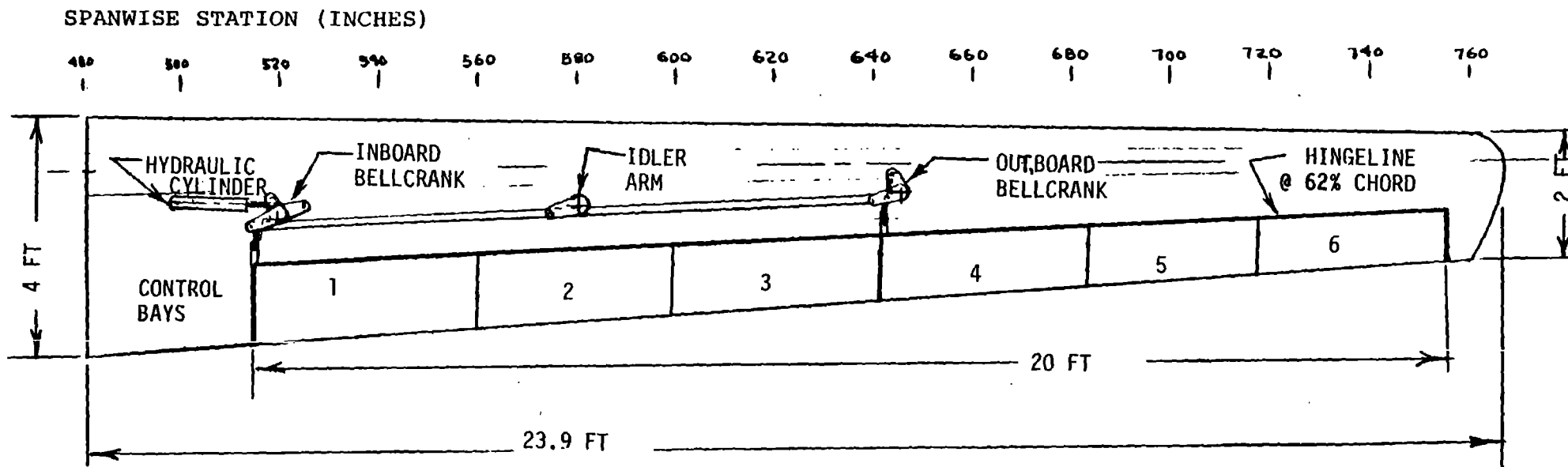
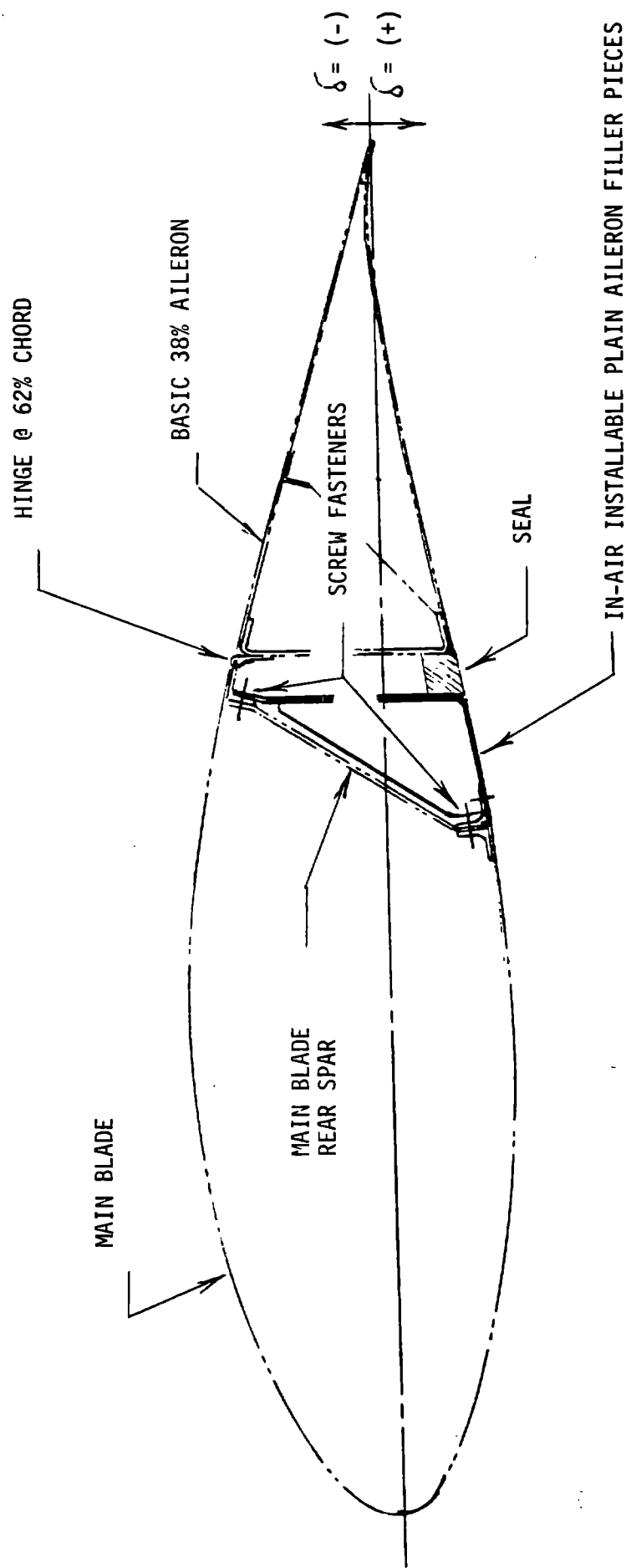
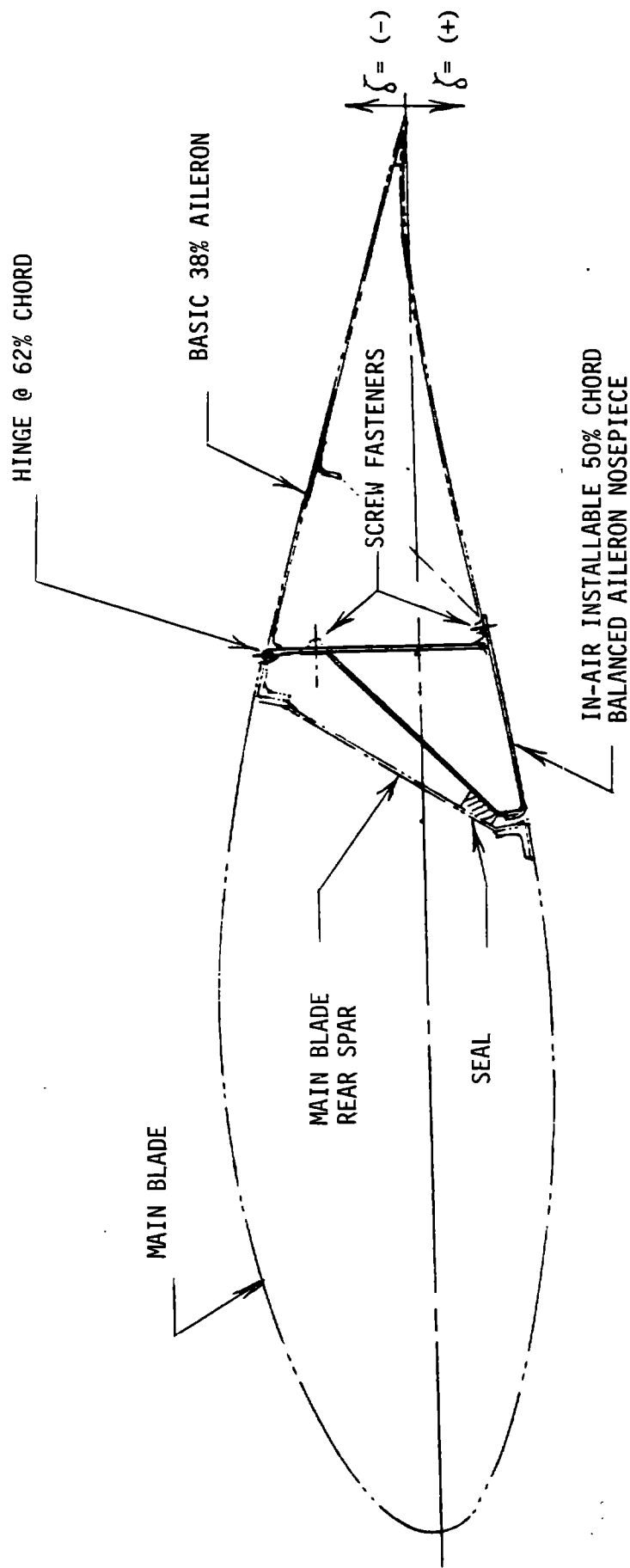


FIGURE 1 - GENERAL ARRANGEMENT OF TEST UNIT AND CONTROL SYSTEM



- NOTES:
- MAXIMUM DEFLECTIONS: $\delta = +10^\circ$ TO $\delta = -105^\circ$
 - FILLER PIECES (6 PER BLADE) ARE REMOVED/INSTALLED WITH AILERON DEFLECTED $\delta = -90^\circ$

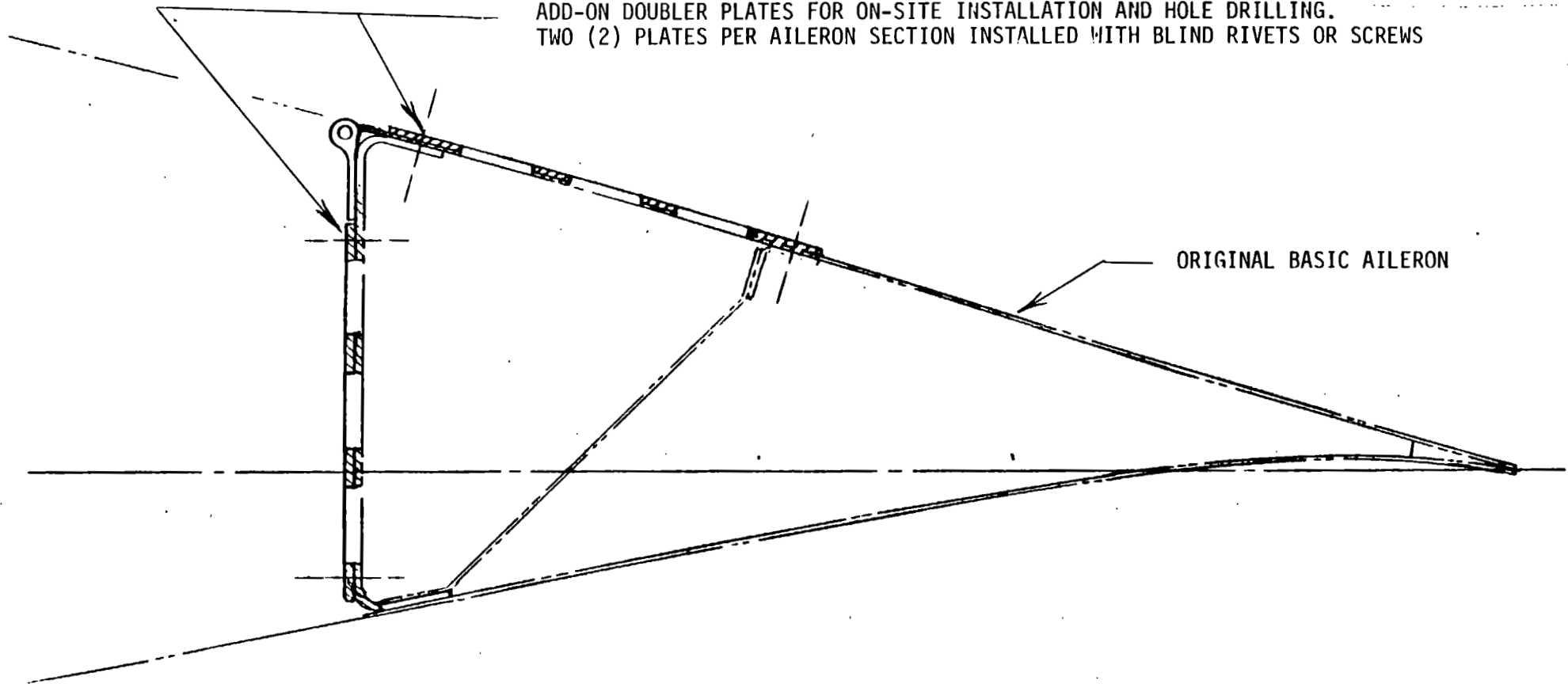
FIGURE 2 - PLAIN AILERON CONFIGURATION



NOTES: - MAXIMUM DEFLECTIONS: $\delta = 0$ TO $\delta = -105^\circ$
 - NOSE PIECES (6 PER BLADE) INSTALLED WITH AILERON $\delta = -90^\circ$ AFTER REMOVAL OF PLAIN AILERON FILLER PIECES (FIGURE 2)

FIGURE 3 - BALANCED AILERON CONFIGURATION

ADD-ON DOUBLER PLATES FOR ON-SITE INSTALLATION AND HOLE DRILLING.
TWO (2) PLATES PER AILERON SECTION INSTALLED WITH BLIND RIVETS OR SCREWS



NOTE: SKETCH SHOWS PLAIN AILERON. CONVERSION OF BALANCED CONFIGURATION IS SIMILAR. AILERON SECTIONS TO BE REMOVED FROM BLADE FOR ON-GROUND CONVERSION TO VENTED CONFIGURATION

FIGURE 4 - FIELD CONVERSION CONCEPT FOR VENTILATION OF BASIC AILERONS

chord trailing edge control surface hinged at the 62% chordline. The details of the basic balanced aileron and the technique for converting from the plain configuration are shown in Figure 3. This configuration consists of a 38% chord plain aileron on the low pressure side, augmented by a 50% chord "spoiler" lip which extends from the high pressure side of the airfoil when the aileron is deflected. The entire integral balanced aileron is again hinged at the 62% chordline on the low pressure side of the blade. Figure 4 shows the concept of on-site venting conversion of the plain aileron. A similar conversion is available for the balanced aileron. Note that in both cases, the basic ailerons can be easily converted to the vented configurations shown in Figure 4 by field installation of doubler plates and vent hole drilling as shown. Variation in the relative amount of venting can be achieved by sealing some of the vent holes with tape. Note, however, that conversion back to the clean basic configuration is not possible once the venting modification has been implemented.

3.2.3 Design and Fabrication

A detailed set of hardware performance requirements and interface specifications for the test unit were developed by GE. The detail design and fabrication of the test unit based on these specs and requirements, were the responsibility of the selected vendor, Schweizer Aircraft Corp., with technical direction and design approval by GE. The vendor will also provide documented stress analyses and structural/operational proof-test data, as required by NASA Safety guidelines. Proof testing for design verification will be conducted with GE and NASA assistance and attendance.

4.0 TEST MATRIX

4.1 GENERAL COMMENTS

Test priority is designed to rapidly assess the overall acceptability/non-acceptability of the aileron configuration determined to be most optimum for the MOD-5A WTG application from earlier studies. The following prime and backup configurations are available for Phase I test:

Plain Aileron	}	Prime Configurations
Balanced Aileron		
Vented Plain Aileron	}	Backup Configurations
Vented Balanced Aileron		

The prime configurations, if required, can be converted in the field to the backup vented configurations by permanent modification using a field installable kit. Wind tunnel data and analyses to date have indicated that the basic 38% chord plain aileron will meet or exceed MOD-5A aileron performance requirements without either balance lip or venting, so utilization of balanced aileron or backup hardware is not presently anticipated, and is included only for contingency test purposes.

The tests are prioritized to evaluate the most critical aileron performance characteristics in order of decreasing criticality:

- 0) Low speed hardware checkout (including speed/power regulation and shutdown)
- 1) Autorotation speed/shutdown (emergency and normal shutdowns)
- 2) Autorotation speed/shutdown with damaged aileron (emergency and normal shutdowns)
- 3) Speed regulation
- 4) Power regulation above rated windspeed
- 5) Noise level during regulation

Items 1) and 2) are significantly more critical parameters since in the regulation cases of 3) and 4), significant improvements in undesirable control characteristics can be provided by stability augmentation derived from modern control systems. Data from earlier NASA tests with 20% - 30% ailerons also indicate reasonable regulation characteristics. Damaged aileron performance item 2), although more critical than speed/power regulation, is scheduled after the regulation tests since it requires an in-air hardware change.

Since the primary purpose of the Phase I tests is to firmly establish the acceptability of the aileron as a rotor control device with acquisition of basic aileron aerodynamic data of only secondary importance, the following approach was employed in the design/prioritization of the test matrix:

- 1) Select most promising basic aileron configuration (plain aileron) from available studies and data as the first test configuration. Do not start with ventilated configurations unless available data and analysis results clearly indicate need for a ventilated concept.
- 2) Demonstrate acceptable autorotation and shutdown performance over range of windspeeds, control rates and aileron deflections.
- 3) Demonstrate acceptable autorotation and shutdown with damaged aileron (outboard 50% span on one blade "jammed" at zero deflection) over range of windspeeds.
- 4) Assess performance acceptability of selected aileron configuration (plain aileron) from above tests.* If acceptable, continue power regulation and speed

*As noted above, "damaged aileron" tests may be conducted after "regulation" tests to avoid extra in-air changes.

regulation tests with same configuration over range of test variables:

Rotor Speed (N)
Windspeed (V_w)
Aileron Deflection Rate ($\dot{\delta}$)
Power output level (P)

If unacceptable, change to balanced aileron configuration and repeat 2) and 3).

- 5) Assess regulation performance and noise levels from tests of 4). If acceptable, continue into "basic aero data acquisition" portion of matrix with the same aileron configuration (fixed deflections, various wind speeds, and two rotor speeds to check Reynold's number effects).
- 6) Evaluate data base to determine need for further testing with same or other basic aileron configuration. Implement additional tests as required and as time permits.
- 7) If stopping/autorotation performance of both plain and balanced aileron configuration is unacceptable in 4), acquire limited regulation and basic data to serve as baseline before converting to ventilated configurations.

- 8) Convert to ventilated configuration if necessary, repeat 1) - 4) with ventilated plain and balanced configurations.
- 9) Ventilation holes can be taped over to simulate reduced ventilation or clean unventilated configurations if necessary.

The major simulation parameter employed in the test is the tip speed ratio (λ) which provides a spanwise angle-of-attack distribution over the MOD-0/5A tip which very nearly duplicates that on the MOD-5A tip under conditions of autorotation, rated windspeed and cutoff windspeed. Mod-0/5A operating condition ($N=20$ rpm) which correspond to the full-scale MOD-5A operating at rated and cutoff windspeeds are $V_w=10$ mph and $V_w=20$ mph, respectively. Test conditions in the matrix are selected to provide duplication of tip speed ratios over a range including these operating points of the MOD-5A as well as autorotation conditions. In most cases, data point acquisition requires accumulation of data in windspeed "bins" of 5 mph width.

Power output as a function of windspeed for the MOD-0/5A hardware operating at 20 rpm is assumed at:

P = 35kw	$V_w = 10$ mph
70kw	20 mph
100kw	30 mph

These estimates are based on previous NASA experience with the MOD-0 WTG.

4.2 TEST MATRIX

A typical test matrix for a single aileron configuration is presented in Table I. The plain aileron is currently the selected prime configuration and will be tested first unless future results from ongoing studies indicate a change to another prime configuration prior to start of testing. In general it is anticipated that either of the basic unventilated configurations would require testing over the entire range of deflections indicated in Table I while the ventilated versions would only be tested at high deflections (-60°, -75°, -95°) to demonstrate improved stopping/autorotation performance if necessary.

Estimated data times are included in the matrix and summarized on the last page of the matrix. These times represent actual data recording times and should be at least doubled to estimate actual running times to account for operational problems, etc., encountered after initial setup and checkout are completed. Also, data times may need to be extended or reduced depending on additional data-scatter experience gained during the tests.

Need for Phase II testing and the Phase II Test Matrix (Table II) will be defined after Phase I testing has been completed and results evaluated.

4.3 SCHEDULE OF TESTING

The testing for Phase I shall conform to the schedule in Table III and follow the matrix of Table I. The prime configuration (plain aileron) will be tested first unless early testing indicates that the configuration will not meet requirements. The contingency path in Table III will then be followed where a

switchover to the balanced aileron will be made and that configuration tested. Further contingency (not shown in Table III) paths would occur if neither the basic plain nor the balanced aileron is acceptable. These paths would result in conversion to the vented configurations after acquisition of limited basic data on one or both unvented configurations at low deflection angles.

PHASE I

TABLE I MATRIX OF TESTS

"SEE FOLLOWING NINE PAGES"

	DATA PT. NO.	AILERON CONFIG.	δ (DEG)	$\dot{\delta}$ (DEG/SEC)	ROTOR RPM	LOAD	λ	WINDSPEED (MPH)	OBJECTIVE	REQ'T.** NO.	SUCCESS** CRITERIA	DATA TIME+ (MIN)
LOW SPEED C/O	D-1	UNDAMAGED PRIME CONF.*	0 + VAR	5	0 + 13	0	6-4 (FINAL)	10-15	LO. SPD. C/O SPD CONTROL	2.2.1	SYNC. N _E 5%	10
	2		VAR	5	13	GRID (P=20KW)	6-4	10-15	LO. SD. C/O PWR. CONTROL	2.2.2	REGUL. OK P _E 20KW	10
	3		+45	25	13 + N _E	DROP LOAD (P=20KW)	6-4 (INITIAL)	10-15	LO. SPD. C/O EMER. STOP	2.1.1	OVER SP < 20% $\lambda_E \geq 1.5$	10
AUTOROTATION SPEED	4		-45	0	N _E	0	λ_E	10-15	N _E vs V _M	2.1.1	$\lambda_E \geq 1.5$	10
	5		-45					15-20				10
	6		-45					20-30				10
	7		-60					10-15				10
	8		-60					15-20				10
	9		-60					20-30				10
	10		-75					10-15				10
	11		-75					15-20				10
	12		-75	0	N _E	0	λ_E	20-30	N _E vs V _M		$\lambda_E \geq 1.5$	10
	13		+95	25	13 + N _E	DROP LOAD (P=20KW)	-	10-15	LO SPD C/O EMER STOP		OVER SPD < 20% $\lambda_E \geq 1.5$	10
LOW SPD. C/O AUTOROTATION	14		-95	0	N _E	0	λ_E	10-15	N _E vs V _M		$\lambda_E \geq 1.5$	10
	15							15-20				10
	16							20-30				10
	17		-95	0	N _E	0	λ_E	40 (-)	N _E vs V _M	2.1.1	$\lambda_E \geq 1.5$	10
	18		0 + VAR	5	0 + 20	0	9-3 (FINAL)	10-30	SPD CONTROL	2.2.1 2.3	SYNC N _E 5%	10
PWR. CONTR. C/O	19		VAR	5	20	GRID (P=35KW)	9-3	10-30	PWR CONTROL	2.2.2 2.3	REGUL OK P _E 20KW	10
	20		+45	25	20 + N _E	DROPLD (P=35KW)	9-6 (INITIAL)	10-15	EMERGENCY SHUTDOWN	2.1.1	OVER SP < 20% $\lambda_E \geq 1.5$	10
	21		+60									10
	22	UNDAMAGED PRIME CONF.*	+75	25	20 + N _E	DROPLD (P=35KW)	9-6 (INITIAL)	10-15	EMERGENCY SHUTDOWN	2.1.1	OVER SP < 20% $\lambda_E \geq 1.5$	10

* PRIME CONFIGURATION IS EITHER UNVENTED PLAIN OR UNVENTED BALANCED AILERON DEPENDING ON RESULTS OF ALL PRETEST ANALYSIS/TEST.
** REQUIREMENT NOS. AND SUCCESS CRITERIA ARE TAKEN FROM SECTION 2
+ DATA TIME IS ESTIMATED LENGTH OF DATA RECORD REQUIRED TO OBTAIN ACCEPTABLE DATA SCATTER, OR ESTIMATED TIME TO RUN A SHUTDOWN TEST.

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	DATA PT. NO.	AILERON CONFIG.	δ (DEG)	$\dot{\delta}$ (DEG/SEC)	ROTOR RPM	LOAD	λ	WINDSPEED (MPH)	OBJECTIVE	REQ'T. ** NO.	SUCCESS ** CRITERIA	DATA TIME* (MIN)
EMERGENCY SHUTDOWN	D-23	UNDAMAGED PRIME CONF.	± 95	25	$20 \rightarrow N_E$	DROPLoad (P=35KW)	9-6 (INITIAL)	10-15	EMERGENCY SHUTDOWN	2.1.1	OVER SPD < 20% $\lambda_E \leq 1.5$	10
	24		± 60	25		DROPLoad (P=50KW)	6-4.5 (INITIAL)	15-20				10
	25		TBD			↓	↓	↓				10
	26					DROPLoad (P=50KW)	6-4.5 (INITIAL)	15-20				10
	27					DROPLoad (P=100KW)	4.5-3 (INITIAL)	20-30				10
	28			25		DROPLoad (P=100KW)	4.5-3 (INITIAL)	20-30	EMERGENCY SHUTDOWN			10
	29			15		DROPLoad (P=35KW)	9-6 (INITIAL)	10-15	EMERGENCY SHUTDN-RATE			10
	30					DROPLoad (P=35KW)	9-6 (INITIAL)	10-15				10
	31					DROPLoad (P=50KW)	6-4.5 (INITIAL)	15-20				10
	32			15		DROPLoad (P=50KW)	6-4.5 (INITIAL)	15-20	EMERGENCY SHUTDN-RATE			10
	33			TBD		TBD	TBD	TBD	EMER. SHUT. CONTINGENCY			10
	34					↓	↓	↓				10
	35		TBD	TBD	$20 \rightarrow N_E$	TBD	TBD	TBD	EMERGENCY CONTINGENCY		OVER SPD < 20% $\lambda_E \leq 1.5$	10
	36		± 60	5	$20 \rightarrow N_E$	GRID + 0 (P=35KW)	9-6 (INITIAL)	10-15	CONTROLLED SHUTDOWN		STABLE dP/dt $\lambda_E \leq 1.5$	10
CONTROLLED SHUTDOWN	37		± 75			↓	↓	↓				10
	38		± 95			GRID + 0 (P=35KW)	9-6 (INITIAL)	10-15				10
	39		± 60			GRID + 0 (P=50KW)	6-4.5 (INITIAL)	15-20				10
	40		± 75			↓	↓	↓				10
	41		± 95	5		GRID + 0 (P=50KW)	6-4.5 (INITIAL)	15-20	CONTROLLED SHUTDOWN			10
	42		TBD	TBD		TBD	TBD	TBD	CONT. SHUT. CONTINGENCY			10
	D-43	UNDAMAGED PRIME CONF.	TBD	TBD	$20 \rightarrow N_E$	TBD	TBD	TBD	CONT. SHUT. CONTINGENCY	2.1.1	STABLE dP/dt $\lambda_E \leq 1.5$	10

	DATA PT. NO.	AILERON CONFIG.	δ (DEG)	$\dot{\delta}$ (DEG/SEC)	ROTOR RPM	LOAD	λ	WINDSPEED (MPH)	OBJECTIVE	REQ'T. ** NO.	SUCCESS ** CRITERIA	DATA TIME + (MIN)
CONTROLLED SHUTDOWN	D-44	UNDAMAGED PRIME CONF.	TBD	TBD	20 \div N _E	TBD	TBD	TBD	CONT. SHUT. CONTINGENCY	2.1.1	STABLE ϕ/dt $\lambda E \pm 1.5$	10
	45		TBD	TBD	20 \div N _E	TBD	TBD	TBD	CONT. SHUT. CONTINGENCY	2.1.1	STABLE ϕ/dt $\lambda E \leq 1.5$	10
SPEED CONTROL & NOISE LEVELS	46		VAR	5	20	0	18-9	5-10	STAB, SPEED CONT, NOISE	2.2.1 2.3 2.4.1	N $\pm 5\%$ SYNC NOISE ACCEPT.	10
	47						9-6	10-15				10
	48						6-4.5	15-20				10
	49				20		4.5-3	20-30				15
	50				10		9-4.5	5-10				10
	51						4.5-3	10-15				10
	52						3-2.3	15-20				10
	53			5	10		2.3-1.5	20-30				15
	54			2	20		18-9	5-10				10
	55			2	20		9-6	10-15				10
POWER CONTROL & NOISE LEVELS	56			TBD	TBD		TBD	TBD				10
	57		VAR	TBD	TBD	0	TBD	TBD	STAB, SPEED CONT, NOISE	2.2.1 2.3 2.4.1	N $\pm 5\%$ SYNC NOISE ACCEPT.	10
	58		VAR	5	20	GRID (P=35KW)	9-6	10-15	STAB, POWER CONT, NOISE	2.2.2 2.3 2.4.1	STAB/NOISE OK, P ± 20 KW	20
	59						6-4.5	15-20				20
	60					GRID (P=35KW)	4.5-3	20-30				20
	61					GRID (P=70KW)	9-6	10-15				20
	62						6-4.5	15-20				20
	63			5		GRID (P=70KW)	4.5-3	20-30				20
	D-64	UNDAMAGED PRIME CONF.	VAR	2	20	GRID (P=35KW)	9-6	10-15	STAB, POWER CONT, NOISE	2.2.2 2.3 2.4.1	STAB/NOISE OK, P ± 20 KW	20

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DATA PT. NO.	AILERON CONFIG.	δ (DEG)	$\dot{\delta}$ (DEG/SEC)	WINDMILL RPM	LOAD	λ	WINDSPEED (MPH)	OBJECTIVE	REQ. NO.	SUCCESS CRITERIA	WIND TIME (MIN)
D-65	UNDAMAGED PRIME CONF	VAR	2	20	GRID (P=35KW)	6-4.5	15-20	STAB, POWER CONT, NOISE	2.4.1 2.2.2 2.3	STAB/NOISE OK, P \geq 20KW	20
66	↓	↓	2	20	GRID (P=35KW)	4.5-3	20-30	↓	↓	↓	20
67	↓	↓	TBD	TBD	GRID (P=TBD)	TBD	TBD	↓	↓	↓	20
68	UNDAMAGED PRIME CONF	VAR	TBD	TBD	GRID (P=TBD)	TBD	TBD	STAB, POWER CONT, NOISE	2.4.1 2.2.2 2.3	STAB/NOISE OK, P \geq 20KW	20
69	25% DAM. PRIME CONF	+ -95	25	13 + N_E	DROP LOAD (P=20KW)	6-4	10-15	DAMAGED AIL. LO SPD C/O	2.1.2	OVERSP. $\leq 20\%$ $\lambda_E \leq 2$	10
70	↓	-95	0	N_E	0	λ_E	10-15	DAMAGED AIL N_E vs V_W		$\lambda_E \leq 2$	10
71	↓	↓	↓	↓	↓	↓	15-20	↓			10
72	↓	-95	↓	↓	↓	↓	20-30	↓			10
73	↓	δ PRIME	↓	↓	↓	↓	10-15	↓			10
74	↓	δ PRIME	↓	↓	↓	↓	15-20	↓			10
75	↓	δ PRIME	↓	↓	↓	↓	20-30	↓			10
76	↓	TBD	↓	↓	↓	↓	10-15	↓			10
77	↓	↓	↓	↓	↓	↓	15-20	↓			10
78	↓	TBD	0	N_E	0	λ_E	20-30	DAMAGED AIL. N_E vs V_W		$\lambda_E \leq 2$	10
79	↓	+ -95	25	20 + N_E	DROP LOAD (P=35KW)	9-6 (INITIAL)	10-15	DAMAGED AIL EMER. SHUT		OVERSPD $\leq 20\%$ $\lambda_E \leq 2$	10
80	↓	↓	↓	↓	DROP LOAD (P=50KW)	6-4.5 (INITIAL)	15-20	↓			10
81	↓	+ -95	25	20 + N_E	DROP LOAD (P=50KW)	4.5-3 (INITIAL)	20-30	↓			10
82	↓	PRIME CONFIG.	PRIME CONFIG.	↓	DROP LOAD (P=35KW)	9-6 (INITIAL)	10-15	↓			10
83	↓	↓	↓	↓	DROP LOAD (P=50KW)	6-4.5 (INITIAL)	15-20	↓			10
84	↓	PRIME CONFIG.	PRIME CONFIG.	20 + N_E	DROP LOAD (P=50KW)	4.5-3 (INITIAL)	20-30	↓			10
85	↓	TBD	TBD	TBD	TBD	TBD	TBD	↓			10
86	↓	↓	↓	↓	↓	↓	↓	↓			10
D-87	25% DAMAGED PRIME CONF	TBD	TBD	TBD	TBD	TBD	TBD	DAMAGED AIL. EMER. SHUT	2.1.2	OVERSP $\leq 2\%$ $\lambda_E \leq 2.0$	10

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D-88	25% DAMAGED PRIME CONF.	+ -95	5	20 + N_E	GRID + 0 (P=35KW)	9-6 (INITIAL)	10-15	DAMAGED AIL. CONT. SHUT.	2.1.2	STABLE STOP $\lambda_E \leq 2.0$	10
89		+ -95	5		GRID + 0 (P=50KW)	4.5-3 (INITIAL)	20-30				10
90		PRIME CONFIG.	PRIME CONFIG.		GRID + 0 (P=35KW)	9-6 (INITIAL)	10-15				10
91		PRIME CONFIG.	PRIME CONFIG.	20 + N_E	GRID + 0 (P=50KW)	4.5-3 (INITIAL)	20-30				10
92		TBD	TBD	TBD	TBD	TBD	TBD				10
93		TBD	TBD	TBD	TBD	TBD	TBD				10
D-94	25% DAMAGED PRIME CONF.	TBD	TBD	TBD	TBD	TBD	TBD	DAMAGED AIL. CONT. SHUT.	2.1.2	STABLE STOP $\lambda_E \leq 2.0$	10

END OF DEMONSTRATION TEST SERIES FOR ONE AILERON CONFIGURATION INCLUDING UNDATED AND DAMAGED (25%) AILERONS

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8-1	UNDAMAGED PRIME CONF.	0	0	20	GRID	18-9	5-10	BASIC AERO DATA, FIX 6	ALL	SUFFICIENT SAMPLE	20
2		↓				9-6	10-15				20
3		↓				6-4.5	15-20				20
4		0				4.5-3	20-30				20
5		-10				18-9	5-10				20
6		↓				9-6	10-15				20
7		↓				6-4.5	15-20				20
8		-10				4.5-3	20-30				20
9		-20				18-9	5-10				20
10		↓				9-6	10-15				20
11		↓				6-4.5	15-20				20
12		-20				4.5-3	20-30				20
13		-25				18-9	5-10				20
14		↓				9-6	10-15				20
15		↓				6-4.5	15-20				20
16		-25				4.5-3	20-30				20
17		-30				18-9	5-10				20
18		↓				9-6	10-15				20
19		↓				6-4.5	15-20				20
20		-30				4.5-3	20-30				20
21		-35				18-9	5-10				20
8-22	UNDAMAGED PRIME CONF.	-35	0	20	GRID	9-6	10-15	BASIC AERO DATA, FIX 6	ALL	SUFFICIENT SAMPLE	20

BASIC DATA, HIGH RE, LOW λ

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	DATA PT. NO.	AILERON CONF.	δ (DEG)	$\dot{\delta}$ (DEG/SEC)	ROTOR RPM	LOAD	λ	WINDSPEED (MPH)	OBJECTIVE	REQ'T.** NO.	SUCCESS** CRITERIA	DATA TIME+ (MIN)
HIGH Re. LOW	B-23	UNDAMAGED PRIME CONF	-35	0	20	GRID	6-4.5	15-20	BASIC, AERO DATA, FIX 8	ALL	SUFFICIENT SAMPLE	20
	24		-35				4.5-3	20-30				20
BASIC DATA, HIGH Re., HIGH	25		-45				18-9	5-10				20
	26		↓				9-6	10-15				20
	27		↓				6-4.5	15-20				20
	28		-45				4.5-3	20-30				20
	29		-60				18-9	5-10				20
	30		↓				9-6	10-15				20
	31		↓				6-4.5	15-20				20
	32		-60				4.5-3	20-30				20
	33		-75				18-9	5-10				20
	34		↓				9-6	10-15				20
	35		↓				6-4.5	15-20				20
	36		-75				4.5-3	20-30				20
	37		-95				18-9	5-10				20
	38		↓				9-6	10-15				20
	39		↓				6-4.5	15-20				20
	40		-95				4.5-3	20-30				20
CONTINGENCY	41		81				18-9	5-10				20
	42		↓				9-6	10-15				20
	43		↓				6-4.5	15-20				20
	B-44	UNDAMAGED PRIME CONF	81	0	20	GRID	4.5-3	20-30	BASIC AERO DATA, FIX 8	ALL	SUFFICIENT SAMPLE	20

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HIGH R ₀ CONTINGENCY	B-45	UNDAMAGED PRIME CONF.	82	0	20	GRID	18-9	5-10	BASIC AERO DATA, FIX 8	ALL	SUFFICIENT SAMPLE	20
	46	↓	↓	↓	↓	↓	9-6	10-15	↓	↓	↓	20
	47	↓	↓	↓	↓	↓	6-4.5	15-20	↓	↓	↓	20
	48	UNDAMAGED PRIME CONF.	82	0	20	GRID	4.5-3	20-30	BASIC AERO DATA, FIX 8	ALL	SUFFICIENT SAMPLE	20
BASIC DATA, LOW R ₀ , ALL δ + CONT.	49	UNDAMAGED PRIME CONF.	-25	0	13	GRID	12-6.5	5-10	BASIC AERO RE, FIX 8	ALL	SUFFICIENT SAMPLE	20
	50	↓	↓	↓	↓	↓	6.5-4	10-15	↓	↓	↓	20
	51	↓	-25	↓	↓	↓	4-3	15-20	↓	↓	↓	20
	52	↓	-45	↓	↓	↓	12-6.5	5-10	↓	↓	↓	20
	53	↓	↓	↓	↓	↓	6.5-4	10-15	↓	↓	↓	20
	54	↓	-45	↓	↓	↓	4-3	15-20	↓	↓	↓	20
	55	↓	-95	↓	↓	↓	12-6.5	5-10	↓	↓	↓	20
	56	↓	↓	↓	↓	↓	6.5-4	10-15	↓	↓	↓	20
	57	↓	-95	↓	↓	↓	4-3	15-20	↓	↓	↓	20
	58	↓	TBD	↓	↓	↓	TBD	TBD	↓	↓	↓	20
	59	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	20
	B-60	UNDAMAGED PRIME CONF.	TBD	0	13	GRID	TBD	TBD	BASIC AERO RE, FIX 8	ALL	SUFFICIENT SAMPLE	20

- END OF BASIC AERO DATA TESTS. COMPLETE SET OF DEMO & BASIC DATA WILL BE ACQUIRED ONLY ON THE SELECTED "PRIME" MOD-5A CONFIGURATION UNLESS ADDITIONAL DATA ARE REQUIRED TO SELECT SPECIFICS OF THE MOD-5A DESIGN. MORE DATA MAY BE ACQUIRED IN PHASE II TESTS.
- DEMO TESTS (D-1 THRU D-94, OR PARTS THEREOF) WILL BE PERFORMED ON ALTERNATIVE CONFIGURATIONS ONLY WHEN/IF SELECTED "PRIME" AILERON CONFIGURATION FAILS TO MEET SUCCESS CRITERIA AS LISTED.
- VENTED CONFIGURATIONS, IF REQUIRED, WILL ONLY BE SUBJECTED TO HIGH δ , AUTO ROTATION & SHUTDOWN TESTS. BASELINE SPEED/POWER REGULATION & BASIC AERO DATA SHALL BE ACQUIRED ON THE BASIC UNVENTED CONFIGURATION BEFORE CONVERSION OF HARDWARE TO VENTED AILERON CONFIGURATIONS.
- ALTERNATIVE CONFIGURATIONS SHALL BE SUBJECTED TO TESTING, AS REQUIRED, AT THE SAME MATRIX CONDITIONS DESCRIBED ABOVE (EITHER FULL OR REDUCED NUMBER OF DATA POINTS AS REQUIRED).

MOD-0/5A AILERON DEVELOPMENT
TEST PROGRAM
TEST PLAN 47A380107
NOVEMBER 1983

DATA TIME SUMMARY

(ONE CONFIGURATION)

TEST TYPE	DATA PT NOS.	HOURS OF DATA	DEMO AND BASIC DATA HOURS
1. LO SPEED C/O	D-1,, 2, 3, 13, 69	0.8	0.8 (C/O)
2. AUTOROTATION (UNDAMAGED)	D-4 THRU 12, 14 THRU 17	2.2	6.6 (SHUTDOWN)
3. EMERGENCY SHUTDOWN (UNDAMAGED)	D-20 THRU 35	2.7	
4. CONTROLLED SHUTDOWN (UNDAMAGED)	D-36 THRU 45	1.7	
5. SPEED CONTROL (UNDAMAGED)	D-18, 46 THRU 57	2.3	6.1 (REGULATION)
6. POWER CONTROL (UNDAMAGED)	D-19, 58 THRU 68	3.8	
7. AUTOROTATION (DAMAGED)	D-70 THRU 78	1.5	4.2 (DAMAGED SHUTDOWN)
8. EMERGENCY SHUTDOWN (DAMAGED)	D-79 THRU 87	1.5	
9. CONTROLLED SHUTDOWN (DAMAGED)	D-88 THRU 94	1.2	
10. BASIC DATA - HIGH Re (UNDAMAGED)	B-1 THRU 48	16.0	20.0 (BASIC DATA)
11. BASIC DATA - LOW Re (UNDAMAGED)	B-49 thru 60	4.0	

TOTAL DATA HOURS + 37.7
FOR ONE COMPLETE CONFIGURATION TEST

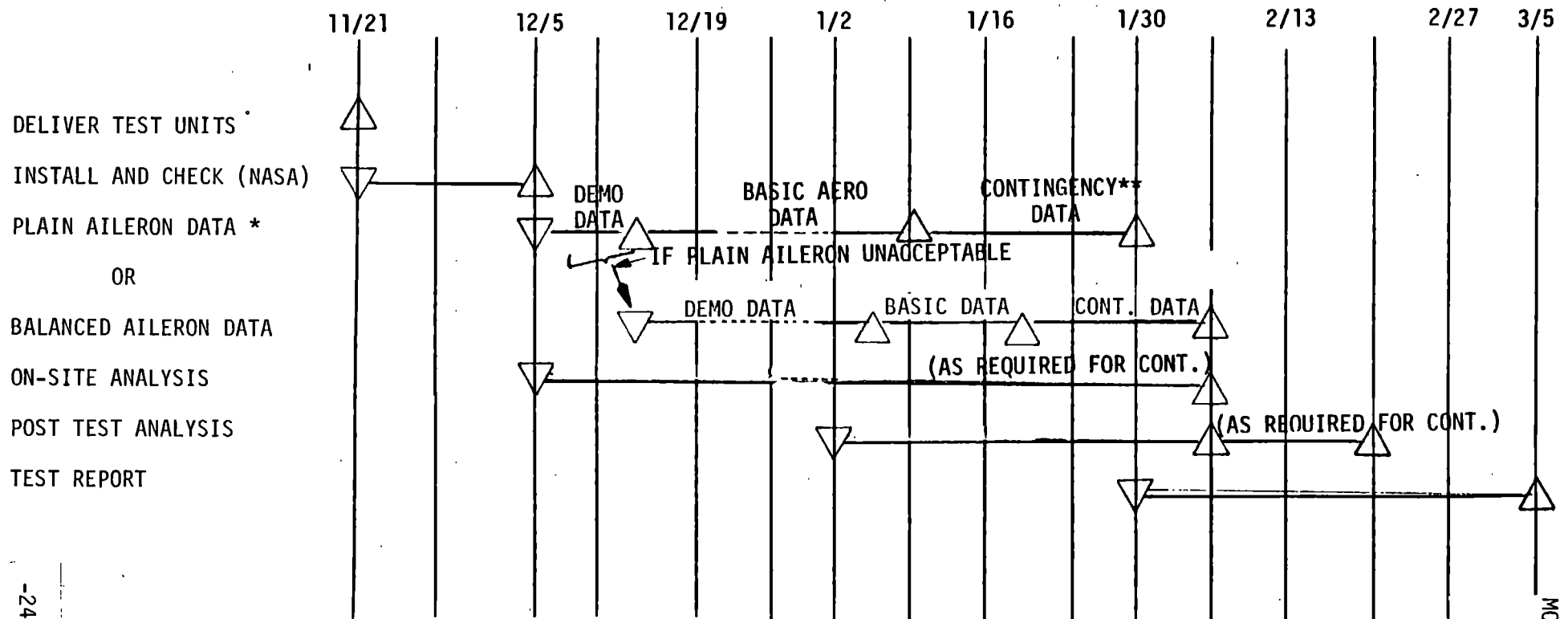
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TABLE II
MATRIX OF TESTS - PHASE II
TBD

TABLE III

MOD-0/5A AILERON TEST SCHEDULE

PHASE I



* PLAIN AILERON IS PRIMARY CONFIGURATION. BALANCED CONFIGURATION WILL BE TESTED ONLY IF PLAIN AILERON DATA INDICATE UNACCEPTABLE PERFORMANCE

** CONTINGENCY TIME INCLUDED FOR POSSIBLE VENTING CONVERSIONS/TEST, EXTENDED DATA ACQUISITION TO IMPROVE SCATTER, WEATHER PROBLEMS, ETC.

TABLE III

MOD-0/5A AILERON TEST SCHEDULE

PHASE II

TBD

5.0 SUPPORT REQUIREMENTS

5.1 LIAISON

GE/AEPD will provide engineering support to coordinate this test and to be present at NASA-LeRC during the test program. NASA personnel will support the proof test and calibration of the test units at Schweizer Aircraft.

5.2 DATA ACQUISITION AND REDUCTION

The test will be conducted by NASA personnel. On-site and post test data reduction will also be conducted by NASA personnel at Plum Brook and at LeRC, Cleveland. Sound-level data reduction will be conducted by NASA LaRC, Langley personnel. Evaluation of reduced data will be the responsibility of GE.

6.0 APPENDICES

6.1 TASK DESCRIPTIONS

1) Define Test Objectives and Requirements (GE)

Define overall objectives and programmatic/technical questions to be answered regarding use of ailerons for MOD-5A Rotor Control.

Define aileron performance acceptance criteria, simulation criteria and requirements, range of parameters for final evaluation.

Define approach for utilization of data in conjunction with other test/analysis tasks of the overall MOD-5A Aileron Development Program.

2) Preliminary Test Plan (GE)

Develop preliminary definition of test approach, hardware configurations, measurement and data requirements, test matrix, and test schedule. Issue preliminary Test Plan Document for early review.

3) Vendor Selection (GE)

Develop and document concept, specification and requirements for GE aileron test units to be tested on NASA Pumbrook MOD-0 machine. Issue RFQ to potential bidders; review vendor capabilities, proposed designs and other proposal information; evaluate bids/bidders and select a vendor for design, fabrication and test/calibration of the test units.

4) Design, Fabrication and Proof Test of Aileron Test Units
(Schweizer/GE Monitor)

- a) Perform engineering design analyses and detailed design of test units to meet requirements and specifications defined by GE. Structure, actuation systems and on-board instrument sensors are included in task.
- b) Fabricate and assemble two test units as per detailed design developed in 4a) above.
- c) Proof test both test units and calibrate all sensors as per requirements defined by GE.

5) Safety Review Inputs (Schweizer/GE)

- a) Perform, theoretical loads and stress analyses to establish the adequacy of the final test unit design in meeting required design margins. Provide documentation for NASA Safety Committee Review.
- b) Evaluate and document the results of the proof tests for final review and acceptance by NASA Safety Committee.
- c) Evaluate potential aileron flutter problems analytically.

6) Update Test Parameters (GE)

Review and evaluate data and results as available from ongoing aileron analyses and wind tunnel programs. Revise test requirements, model configurations, measurement parameters, test matrix, data reduction plans as indicated by new information.

7) Test and Analysis Procedures (NASA and GE)

Develop MOD-0/5A test, instrumentation and data reduction procedures compatible with mutually agreed upon test and data requirements. Task includes definition of operational procedures, sensor and data acquisition parameters, and data reduction techniques.

8) Final Test Plan (GE)

Update the Preliminary Test Plan to the final version incorporating all changes developed as per Tasks 6) and 7). Issue document for final review/approval of NASA and GE management.

9) Data Acquisition and Reduction (NASA/GE Engineering Support)

- a) Install GE Test units on the MOD-0 WTG machine at Plum Brook. Perform initial checkout and preliminary testing as required.
- b) Conduct tests and acquire prime data as per final approved test plan. Perform on-site data evaluation and review to monitor test progress and verify data quality and obtain preliminary aileron performance estimates.
- c) Perform reduction of data at LeRC and LaRC as defined in test plan and NASA procedures.

10) Data Analysis and Evaluation (GE)

Perform other processing, as required, on reduced data, evaluate results and determine aileron performance parameters. Compare measured aileron performance with acceptance criteria as defined in test requirements.

11) Final Report

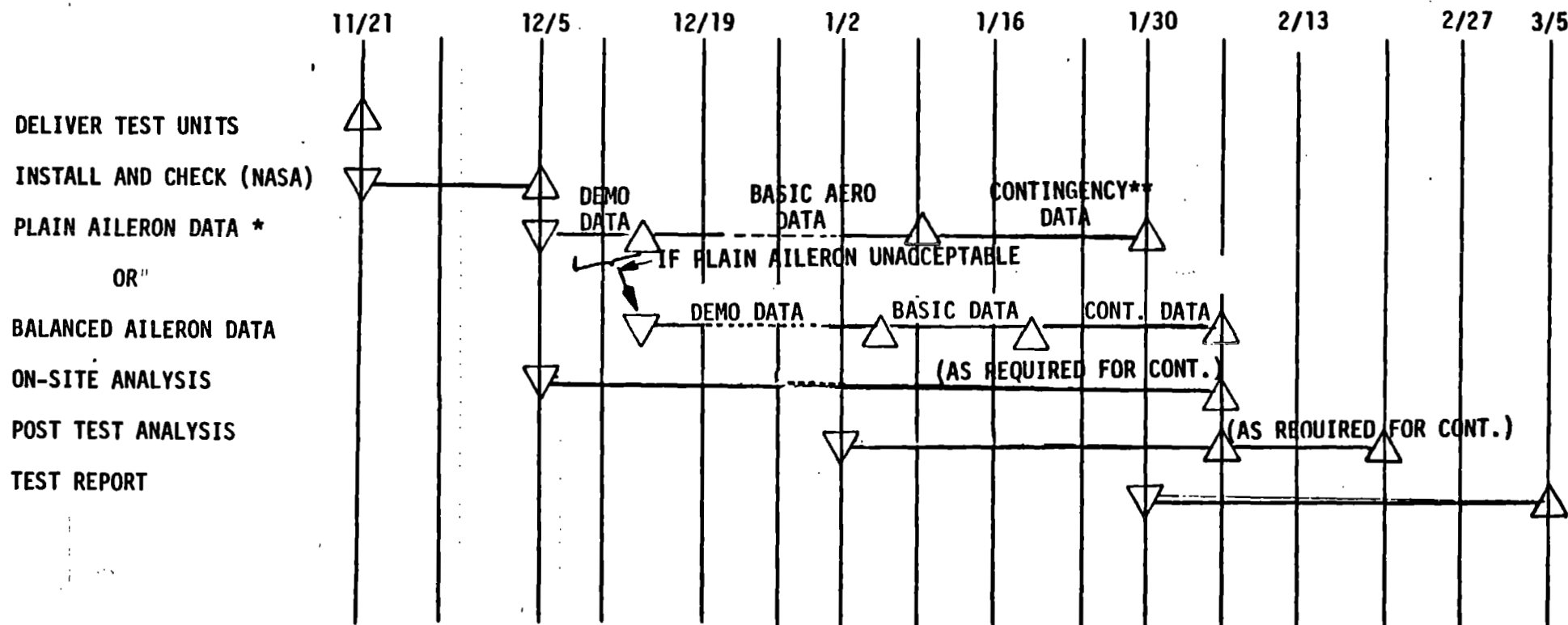
Document MOD-0/5A Phase I test and results in a Final Test Report for review and approval by GE management and NASA.

6.2 OVERALL SCHEDULE

The overall schedule for the above tasks is presented in Table A-I.

TABLE III

GE MOD-05A PHASE I TEST SCHEDULE



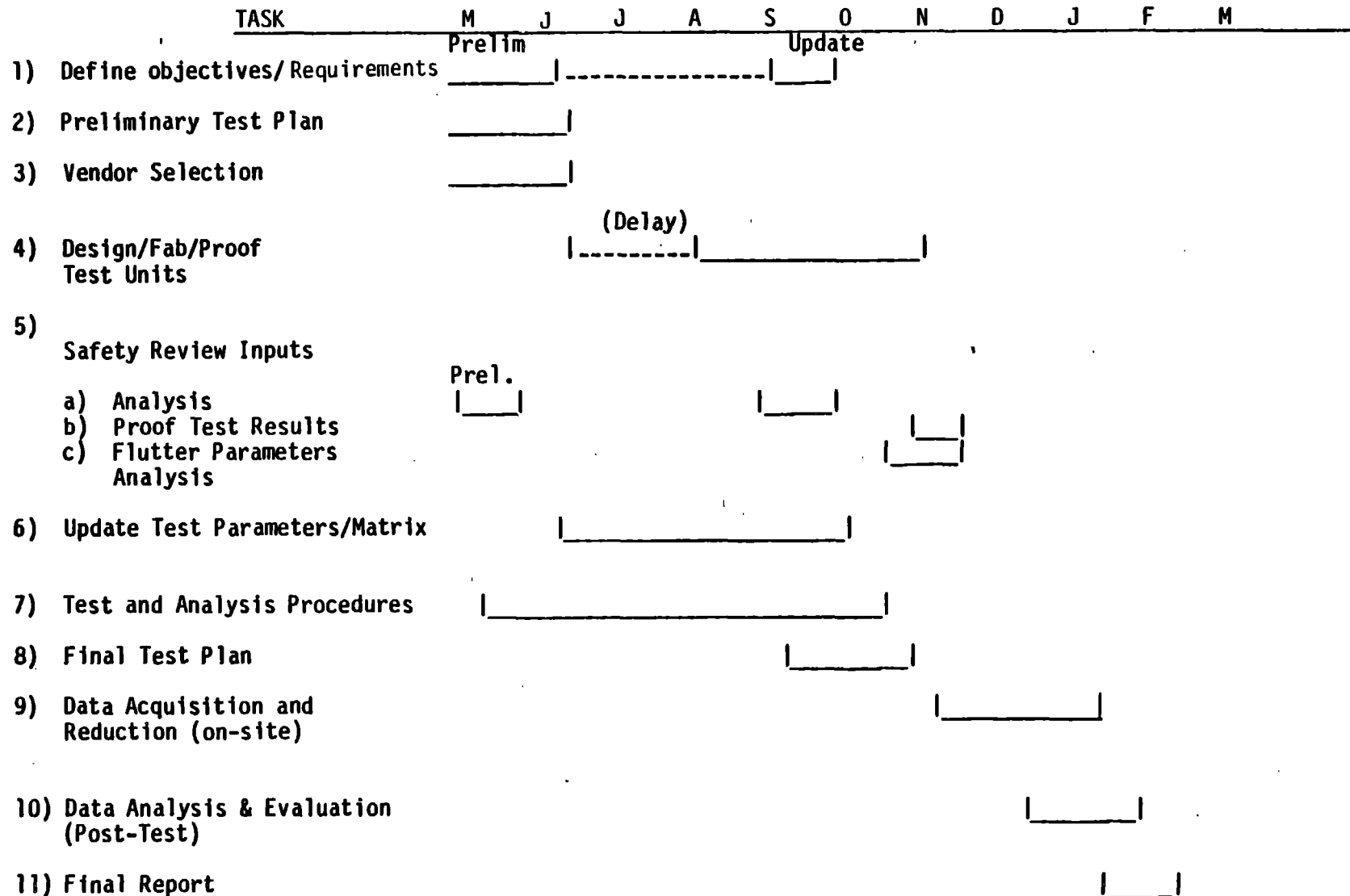
* PLAIN AILERON IS PRIMARY CONFIGURATION. BALANCED CONFIGURATION WILL BE TESTED ONLY IF PLAIN AILERON DATA INDICATE UNACCEPTABLE PERFORMANCE

** CONTINGENCY TIME INCLUDED FOR POSSIBLE VENTING CONVERSIONS/TEST, EXTENDED DATA ACQUISITION TO IMPROVE SCATTER, WEATHER PROBLEMS, ETC.

TABLE A-I

OVERALL MOD-O/5A TEST PROGRAM

TASK SCHEDULE - PHASE I



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COOLER SPECIFICATION FOR THE MOD-5A
GEARBOX LUBRICATION SYSTEM
JUNE 1983

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SECTION 1.0 INTRODUCTION

1.1 SCOPE

The objective of this specification is to define the characteristics of an oil cooler for the MOD-5A Wind Turbine Generator gearbox lubricating oil system.

SECTION 2.0 REQUIREMENTS

2.1 TYPE

The cooler shall be a forced convection, air cooled, finned tube type.

2.2 CONFIGURATION

The cooling system may be comprised of one or more coolers. See Gearbox Lube System Schematic GE Drawing 47E382020.

2.3 WEIGHT

Cooler system weight shall not exceed 2500 lb excluding oil, but including plumbing if multiple coolers are utilized.

2.4 PERFORMANCE AND OPERATING CRITERIA

2.4.1 FLUID

Mobil Oil Co., P/N SHC630.

2.4.2 FLOW

A constant flow of 140 gal/min \pm 10 gal/min will be provided while the wind turbine is in operation.

2.4.3 PRESSURE DROP

Maximum pressure drop through the oil side of the cooler shall be 45 psi at 60°F oil inlet temperature and 140 gal/min flow rate.

2.4.4 HEAT REJECTION

The cooler shall be capable of rejecting 700,000 BTU/hr with a 104°F ambient temperature and 145°F oil inlet temperature.

2.4.5 NOISE

The design requirement shall be 90 dBA maximum at a 13 ft distance from unit.

2.4.6 PRESSURE

The cooler, including piping if applicable, shall be designed to operate with a maximum internal static pressure of 200 psi. In addition the cooler system shall be capable of withstanding a proof pressure test of 300 psig (1.5 times the maximum operating pressure). Also the cooler must be capable of surviving an internal vacuum of 10 mm Hg. absolute.

2.4.7 LEAKAGE

There shall be no evidence of external leakage under normal visual inspection and wipe testing when the system is pressurized to maximum operating pressure.

2.4.8 MATERIAL COMPATIBILITY

All materials of construction shall be compatible with the hydraulic fluid specified in paragraph 2.4.1.

2.4.9 PROTECTIVE COATING

All components of the cooler system exposed to the environment described in paragraph 2.4.12 shall be finished per GE Specification 47A380048, semi-gloss white, per Federal Standard 27875.

2.4.10 POWER SOURCE

A 480 V, 3Ø, 60 Hz power source is available and shall be used whenever possible. Vibration isolation between the fan drive system and main structure shall be provided.

2.4.11 ENVELOPE

The cooler system shall not exceed 75 ft² of projected area.
Standard pipe connections shall be utilized for cooler system piping.

2.4.12 ENVIRONMENT

The cooler system shall be designed to withstand conditions encountered when installed in a range of atmospheric environments experienced from New England to Alaska or the Caribbean area to hot desert climates. Operating temperature extremes of -22°F to 104°F will be experienced. The equipment shall also be capable of withstanding a non-operating environment temperature range of -40°F to +140°F.

Corrosion protection is of primary importance since the environment can include salt spray and/or sand and dust. Equipment should be capable of withstanding an air salt loading of .05 PPM. Any recommended maintenance in order to assure the cooler will provide the life requirement specified in Section 2.5, shall be specified by the supplier.

2.5 LIFE

The design life is 30 years. If the cooler system will not function for the complete design life without service or maintenance action, such actions shall be recommended by the vendor and tabulated as to service frequency, field service or shop service.

The cooler shall be designed for a minimum availability of 99% over the service life.

SECTION 3.0
QUALITY ASSURANCE PROVISIONS

3.1 MANUFACTURING AND TEST FLOW PLAN

The supplier shall submit a manufacturing and test flow plan showing the basic manufacturing operation, special processes, and tests for General Electric review and establishment of GE inspection points.

3.2 INSPECTION BY GENERAL ELECTRIC

General Electric shall maintain cognizance over the supplier quality system and performance on the material to be furnished. The supplier shall notify General Electric forty-eight (48) hours in advance of the time; work, processes, or tests are ready for inspection in accordance with the Manufacturing and Test Flow Plan.

3.3 TESTING

As a minimum the supplier shall conduct the following tests:

- o Proof Pressure Test
- o External Leakage at Operating Pressure

3.4 TEST DATA

The supplier shall record all operating test times and conditions of operation such as pressure and time. One copy of this record shall be submitted to General Electric when cooler system is delivered.

3.5 MATERIAL RECORDS

The supplier shall maintain a file, for General Electric review, of all material inspection records (physical and chemical data), radiographic reports, ultrasonic reports, and similar test data related to the cooler supplied to General Electric.

SECTION 4.0
PREPARATION FOR DELIVERY

4.1 SHIPPING CONTAINERS

The shipping containers and method of shipment shall be approved by the General Electric Company prior to shipment of the Hydraulic Power Supply. All interface connections shall be capped or plugged to prevent entry of contaminants. After testing per 3.0, the system shall be drained and thoroughly cleaned. All strainers and filter elements shall be replaced.

4.2 DOCUMENTATION

The vendor shall supply a Parts List, Service and Maintenance Manuals, Operating Instructions, Reproducible Drawings, List of Recommended Spares and Troubleshooting Instructions for the hydraulic power supply and its component parts. The vendor shall also supply procedures for shutdown, long storage period, and startup inspections.

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SPECIFICATION FOR THE ROTOR
HYDRAULIC POWER SUPPLY
JULY 1983

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SECTION 1.0
INTRODUCTION

1.1 SCOPE

This specification defines the characteristics of a hydraulic power supply for the MOD-5A Wind Turbine Generator. The vendor will work with GE to arrive at a design that will meet the technical requirements described in this document.

SECTION 2.0

APPLICABLE DOCUMENTS

2.1 GENERAL ELECTRIC DRAWINGS

47E382006 Partial Span Control Hydraulic Schematic

47A380002, Rev B Structural Design Criteria for MOD 5A Wind Turbine Generator

2.2 SPECIFICATIONS

MIL-H-5606ATF - Hydraulic Fluid

SECTION 3.0 REQUIREMENTS

3.1 GENERAL

The requirement of this subassembly is to supply hydraulic power to the blade actuation subassemblies and the teeter brake assembly.

3.2 CONFIGURATION

Figure 1 depicts the suggested equipment layout and overall configuration. The subassembly is mounted directly to and rotates with the yoke. The maximum overall dimensions are as shown on Figure 1.

The component support structure must be designed to withstand the "g" loads specified in Section 3.4.1. Figure 2 depicts the interface areas along with definition of removable sections.

3.3 WEIGHT

The weight goal of the subassembly including components, structure, piping, fittings, and fluid is 6500 lb.

3.4 PERFORMANCE AND OPERATING CRITERIA

3.4.1 ENVIRONMENT

The power supply shall be designed to withstand conditions encountered when housed in an unsealed enclosure and rotating as shown in Figure 1. The extreme

3.4.1 ENVIRONMENT (cont'd)

corner of the structure will be exposed to 2.6 ± 1 g at a frequency of .2 to .3 Hz. All component mounting shall be designed for 2.6 ± 1 g in the direction shown in Figure 1.

The subassembly will be located in a range of atmospheric environments experienced from New England to Alaska or the Caribbean area to hot desert climates. Non-operating temperature extremes of -40°F to $+140^{\circ}\text{F}$ will be experienced. The operable temperature range is -22°F to 104°F . Outdoor conditions of rain, hail, sleet, snow, salt spray, etc. will be encountered.

3.4.2 ENVELOPE

Figure 1 illustrates the maximum envelope dimensions (173" x 33" x 51") while Figure 2 depicts the suggested physical layout.

3.4.3 OUTPUT

The power supply shall provide three separate conditions of hydraulic outputs i.e. the normal operating flow rate, the accelerated flow rate and the emergency feather flow rate.

The normal operating flow shall be at a rate of 0-18 gal/min from 0 to 3000 psi via two separate outlets (9 gal/min each). A variable volume, pressure compensated pump shall be utilized. The system shall be such that flow can be momentarily augmented via accumulators to 40 gal/min (20 gal/min each outlet). The duty cycle of the normal operating system shall be continuous.

An accelerated hydraulic flow rate of 40 gal/min (20 gal/min each outlet) for 3 seconds is required to accelerate blade feathering. This rate is provided by two (2) 10 gallon 3000 psi accumulators for each blade. The minimum pressure at the end of the three (3) seconds shall be 1500 psi. The duty cycle of this flow shall be intermittent and is not expected to exceed 20% of the total operating time.

3.4.3 OUTPUT (cont'd)

Two accumulators each 5 gal capacity, 500 psi are provided to supply the low pressure emergency feathering function. Maximum flow rate out of the accumulators will be 22 gal/min. See GE schematic 47E382006 for additional details.

3.4.4 POWER SOURCE

A 480 V, three phase, 60 Hz electrical supply will be provided for the motor. Electrical power requirements to meet the above output shall be determined by the vendor and stated as part of this procurement, but shall not exceed 35 H.P. Electrical motors selected for this service shall exhibit high starting torque capability and be totally enclosed fan cooled.

3.4.5 DUTY CYCLE

Since a major portion of the operation of this unit shall be at low demand flow, the system must provide for minimum parasitic power absorption. The expected duty cycle for these systems is given below:

<u>% Time Of Operation</u>	<u>Normal Operating Supply</u>
30%	12 gpm, 2000 psi
20%	18 gpm, 3000 psi
50%	8 gpm, 1500 psi
<u>% Time Of Operation</u>	<u>Transient Supply</u>
20%	40 gpm, 3000 psi
80%	off (normal supply only)
<u>% Time of Operation</u>	<u>Emergency Feather Supply</u>
5%	22 gpm, 500/psi
95%	Off

3.4.6 FLUID/RESERVOIR

The hydraulic fluid shall be MIL-H-5606 ATF, Dexron II, Mobilfluid 300 or Shell Donax T6. Because this power supply will be rotating while in service a pressurized bladder type reservoir shall be utilized to assure an adequate supply of oil to the pump and also to prevent oil foaming. The normal operating pressure range of the reservoir shall be 5 to 15 PSIG, however it shall be designed for 125 PSIG maximum operating pressure. Total reservoir capacity shall be 80 gallons (fluid plus gas charge). As indicated in Figure 1 it is desirable to have two (2) separate 40 gallon accumulators.

In addition, the reservoir shall be designed such that a blanket heater and insulation can be applied to the reservoir if desired. The reservoir system shall be equipped with a low pressure switch which shall have a nominal setting of 10 psi and an adjustable range of ± 5 psi. An analog pressure transducer shall be provided with a range 0 - 100 psi. Section 3.4.18 defines the electrical characteristics of the sensors.

The system, of which this power supply is a part, is sensitive to air entrainment. It is essential that sump return and pump suction features demonstrate effective provisions for eliminating air entrapment at flows up to 40 gpm.

The bladder is provided to separate the oil from the pressurized nitrogen to eliminate air entrapment, moisture condensation, and collection of airborne contaminants.

3.4.7 FILTERS

The power supply is equipped with a suction filter and a pressure filter as indicated on GE PSC Hydraulic Schematic Drawing 47E382006.

3.4.7.1 Suction Filter

A 75 micron minimum, 150 micron maximum suction filter shall be installed in the suction line between the reservoir and pump. Pressure drop across the filter, when clean, shall not exceed .1 psi at 30 gpm with 150 SSU oil. The filter shall contain a non-by-passing, non-collapsing element of metal construction. It shall incorporate a visual element cleanliness indicator.

3.4.7.2 Pressure Filter

A five (5) micron (nominal) pressure filter shall be installed on the discharge side of the pump as shown on GE PSC schematic 47E382006. Pressure drop across the filter, when clean, shall not exceed 1 psi at 30 gpm of 150 SSU oil. The filter shall contain a non-collapsing, non-bypassing element of metal construction. Additionally the filter shall contain a ΔP switch which will close a set of contacts when a predetermined maximum pressure drop is reached. Section 3.4.18 defines the electrical characteristics of the ΔP switch. The element shall be capable of withstanding without damage or degradation a pressure drop of 3000 psi. The filter housing shall be designed for 4000 psig internal pressure.

3.4.8 SYSTEM PRESSURE LEVELS

Unless otherwise specified all components, fittings, sensing devices, and interconnecting piping shall be designed to operate with an internal pressure of 3000 psig. Exceptions are drain and suction lines, the reservoir and its accessory equipment which shall be designed for an operating pressure of 125 psig. All components shall be capable of withstanding a proof pressure test of 1.5 times the nominal pressure level without degradation of performance. The system and all components shall be capable of surviving an internal vacuum pressure test of 10^{-3} mm Hg absolute.

3.4.9 LEAKAGE

There shall be no evidence of external leakage, under normal visual inspection and wipe testing, when the system is pressurized to normal operating pressure levels. All valves shall exhibit a maximum internal leakage of 1 drop per minute.

3.4.10 MATERIAL COMPATIBILITY

All materials of construction shall be compatible with the hydraulic fluid specified in Section 3.4.6.

3.4.11 LINE SIZES AND MATERIALS

All interconnecting tubing shall be sized for flow rates of 15 fps minimum and 30 fps maximum in accordance with accepted design practice. Material shall be ASTM A-269, type 304, 316, or other approved grades. Where tubing will be welded, types 304L, 316L and 347 shall be used.

3.4.12 DRAINING AND VENTING

Provision shall be made for bleeding, draining and venting all circuits of the hydraulic power supply.

3.4.13 TUBING ASSEMBLIES AND FITTINGS

Tube connections and interfaces shall be welded wherever possible. Wherever welded tubing assemblies are not practical due to component availability or maintenance, Lenz O-ring fittings or equivalent shall be used.

3.4.14 PROTECTIVE COATING

All components of the hydraulic power supply exposed to the environment described in Section 3.4.1 shall be finished per GE Specification 47A380048, semi-gloss white, per Federal Standard 27875.

3.4.15 STRUCTURAL SUPPORT AND INTERFACE

The hydraulic power supply will be mechanically attached to a mechanical support as depicted in Figure 2. Size and location of fasteners will be defined at a later date. The hydraulic component support structure shall be designed in accordance with GE Specification 47A380002, Rev B, Structural Design Criteria for MOD 5A Wind Turbine Generator for the "g" load specified in Section 3.4.1 of this document.

3.4.16 VALVES

The following valves as depicted on the Partial Span Control Hydraulic Schematic 47E382006 shall be the "shear seal" configuration.

Feather Valves A-1, A-2, B-1, B-2

Teeter Low Brake

Teeter High Brake

3.4.17 ACCUMULATORS

All accumulators shall be bladder type and in addition have a design pressure rating of 3000 psi minimum.

3.4.18 SENSORS

All analog sensors shall have a 4-20 ma output and all indicating switches shall have a contact rating of 10 ma (125v, 60Hz).

3.5 GENERAL DESIGN REQUIREMENT

3.5.1 AVAILABILITY

The Hydraulic Power Supply System shall be designed for a minimum availability of 99.6% over the service life, with a minimum MTBF of 4000 hours. Special consideration shall be given to servicing and maintenance of critical areas.

3.5.2 PARTS AND COMPONENTS

The system shall utilize state-of-the-art components with a proven record of experience.

3.5.3 MAINTENANCE AND SERVICEABILITY

The system shall provide for safe and easy maintenance wherever possible, including removable covers or shrouds. All parts and components shall be designed for easy handling and lifting.

3.5.4 TRANSPORTABILITY AND HANDLING

When designing the system, consideration should be given to transportation via existing surface vehicles and handling or lifting by means of a fork lift truck. Lifting lugs or eye bolts shall be provided to facilitate lifting and handling. Lifting provisions shall be designed with a strength safety factor of six (6).

3.5.5 REVIEW AND APPROVAL

Prior to fabrication, the supplier shall submit the detailed design for GE approval that it meets the requirements of this specification.

3.6 DEVIATIONS FROM SPECIFICATION

All deviations from specification and drawings shall be approved by General Electric prior to installation of hardware.

3.7 LIFE

Due to the criticality of this component the design must be extremely reliable. The WTG is being designed for a useful life of 30 years. The supplier shall provide the necessary maintenance instructions and/or component replacement schedule to attain the aforementioned 30 year requirement.

SECTION 4.0
QUALITY ASSURANCE PROVISIONS

The Hydraulic Power Supply System supplier shall provide a brief description of his Quality Control/Inspection System, showing how he controls:

- a) Measuring and Test Equipment
- b) Processes
- c) Materials
- d) Non-conforming Material

4.1 ACCEPTANCE TESTING

The supplier shall provide a brief description of his in-house acceptance tests prior to delivery to the General Electric Company. Two General Electric representatives shall be permitted to witness any or all tests at the vendor's plant. GE Procurement shall be notified forty-eight (48) hours in advance of testing.

4.2 REPORTS

The vendor shall supply three (3) copies of all quality control reports and test results.

4.3 MINIMUM TEST PROGRAM

As a minimum the supplier shall conduct the following tests:

- a) Proof Pressure Test - Pressurize each circuit to 1.5 times its nominal working pressure. Circuit must be tested to full proof pressure with plug replacing relief valve prior to installation of relief valves. Circuits protected by relief valves need to be pressurized to relief valve cracking pressure only. No performance degradation shall occur following this test.

4.3 MINIMUM TEST PROGRAM (cont'd)

- b) External Leakage - "Wipe test" and visually observe all fittings, components and tubing joints for external leaks, with each element pressurized to nominal working pressure. No visible evidence of leakage shall occur for 2 hours.
- c) Functionally test each component under nominal operating conditions. Each power supply shall be run with the outlet dead-ended and the resulting outlet pressure measured. Flow capacity of each supply shall be measured by means of flow meters - flow rate shall meet specified requirement.

SECTION 5.0
PREPARATION FOR DELIVERY

5.1 SHIPPING CONTAINERS

The shipping containers and method of shipment shall be approved by the General Electric Company prior to shipment of the Hydraulic Power Supply. All interface connections shall be capped or plugged to prevent entry of contaminants. After testing per Section 4.0, the system shall be drained and thoroughly cleaned. All strainers and filter elements shall be replaced.

5.2 DOCUMENTATION

The vendor shall supply a Parts List, Service and Maintenance Manuals, Operating Instructions, Reproducible Drawings, List of Recommended Spares and Troubleshooting Instructions for the hydraulic power supply and its component parts. The vendor shall also supply procedures for shutdown, long storage period, and startup inspections.



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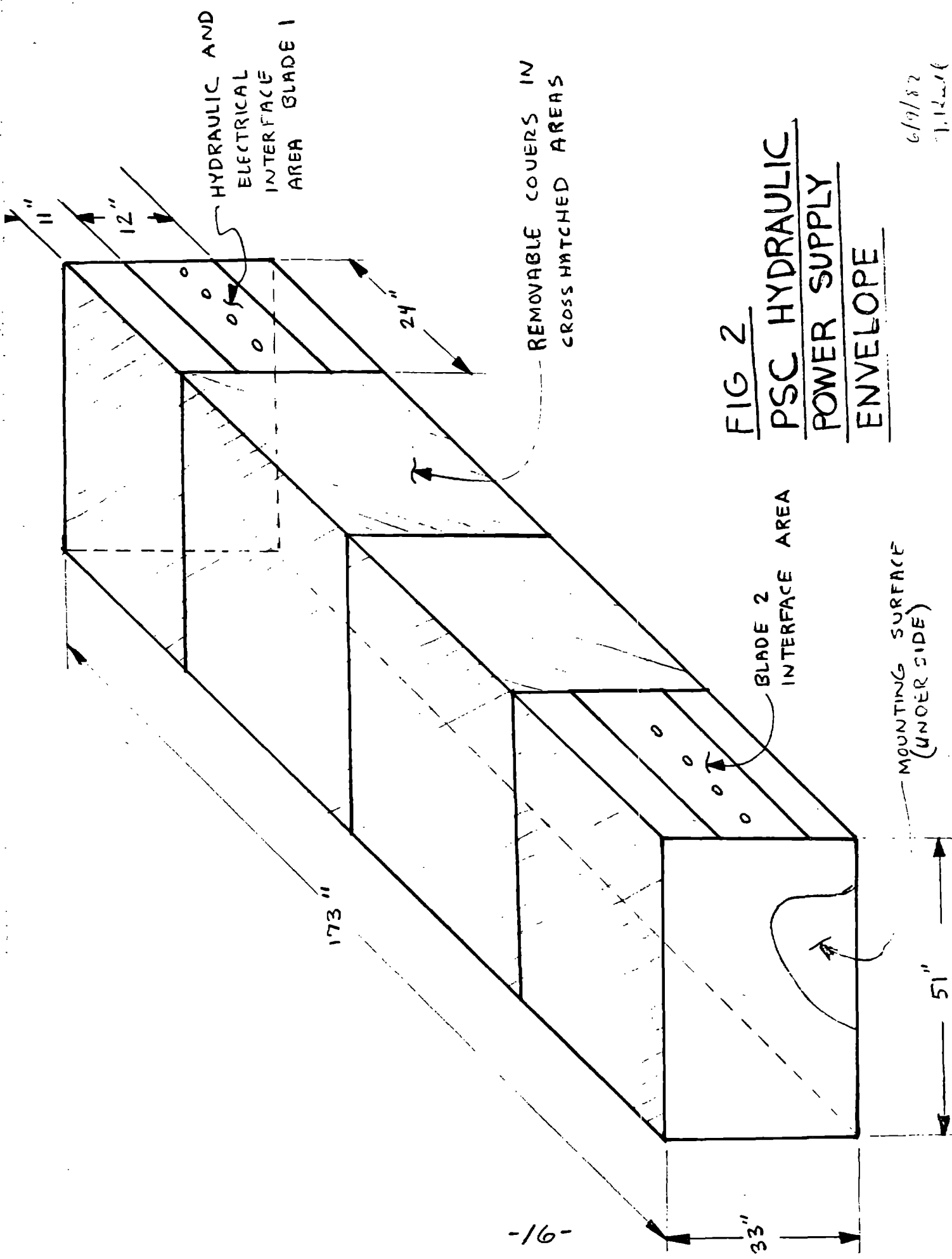


FIG 2
PSC HYDRAULIC
POWER SUPPLY
ENVELOPE

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FIRST MADE FOR

REVISION

SPECIFICATION FOR THE YAW DRIVE

HYDRAULIC POWER SUPPLY

AUGUST 1983

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TOTAL NUMBER OF PAGES 16

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ISSUED

J. V. Schmidt 8/8/83

KING OF PRUSSIA

LOCATION

CONT ON SHEET *ii*

SH NO. *7*

REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

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SECTION 1.0
INTRODUCTION

1.1 SCOPE

The objective of this specification is to describe the characteristics of a hydraulic power supply for the Yaw Drive System of the MOD-5A Wind Turbine Generator. The vendor will work with GE to arrive at a design that will meet the technical requirements described in this document.

SECTION 2.0

APPLICABLE DOCUMENTS

2.1 GENERAL ELECTRIC DRAWINGS

47E382314 Yaw Drive Hydraulic Schematic

2.2 SPECIFICATIONS

MIL-H-5606ATF Hydraulic Fluid

SECTION 3.0 REQUIREMENTS

3.1 GENERAL

The requirement of this unit is to supply hydraulic power to the yaw drive subassembly and rotor holding brake. This unit functions in conjunction with the yaw accumulator package.

3.2 CONFIGURATION

Figure 1 depicts the suggested equipment layout and overall configuration. This subassembly is mounted directly to the upper yaw structure. The maximum overall dimensions and interface areas are depicted in Figure 1.

3.3 WEIGHT

The weight goal of the subassembly including components, structure, piping, fittings, and fluid is 2700 lb.

3.4 PERFORMANCE AND OPERATING CRITERIA

3.4.1 ENVIRONMENT

The power supply shall be designed to withstand conditions encountered when housed in an unsealed protected enclosure. The subassembly will be located in a range of atmospheric environments experienced from New England to Alaska or the Caribbean area to hot desert climates. Non-operating temperature extremes of -40°F to +140°F will be experienced. The operable temperature range is -22°F to 110°F. Outdoor conditions of rain, hail, sleet, snow, salt spray, etc. will be encountered during storage and installation.

3.4.2 ENVELOPE

Figure 1 illustrates the maximum envelope dimensions (54" x 53" x 22").

3.4.3 OUTPUT

The power supply shall be capable of providing an output of 5 gal/min at pressures up to 3000 psi. A fixed volume piston pump shall be utilized to provide the hydraulic power. A relief valve shall be provided at the pump discharge and sized to pass 5 gal/min for 20 minutes without overheating.

See GE schematic 47E382314 for additional details.

3.4.4 POWER SOURCE AND CONTROL

A 480 V, three phase, 60 Hz electrical supply will be provided for the motor. Electrical power requirements to meet the above output shall be determined by the vendor and stated as part of this procurement, but shall not exceed 10 H.P. Electrical motors selected for this service shall exhibit high starting torque capability and be totally enclosed fan cooled. A motor starting contactor with thermal overloads and 120 vac control circuit shall be provided, mounted and wired.

3.4.5 DUTY CYCLE

The expected duty cycle for this system is given below. A major portion of the operating time is at low pressures or off, therefore the system must provide for multiple pump motor starting and extended periods of no pump generation.

<u>% Time Of Operation</u>	<u>Normal Operating Supply</u>
15%	5 gpm, 2000 psi
15%	5 gpm, 3000 psi
70%	off

3.4.6 FLUID/RESERVOIR

The hydraulic fluid shall be MIL-H-5606 ATF, Dexron II, Mobil fluid 300 or Shell Donax T6.

Total reservoir capacity shall be 20 gallons. A diaphragm or bladder shall separate the oil from ambient air to eliminate air entrapment, moisture condensation, and collection of airborne contaminants. A sealed breather (bladder accumulator) in place of the breather vent will satisfy the requirement. The reservoir shall be designed for 125 psig maximum operating pressure.

In addition, the reservoir shall be designed such that immersion heaters can be installed into the reservoir if desired. A high temperature switch ($180^{\circ}\text{F} \pm 10^{\circ}\text{F}$ set point) shall also be installed into the reservoir.

It is essential that sump return and pump suction features demonstrate effective provisions for eliminating air entrapment at flows up to 5 gpm.

A level switch shall be provided which will give a signal when oil level reaches a preset low level.

3.4.7 FILTERS

The power supply is equipped with a suction filter and a pressure filter as indicated on GE Yaw Schematic Drawing 47E382314.

3.4.7.1 Suction Filter

A 75 micron minimum, 150 micron maximum suction filter shall be installed in the suction line between the reservoir and pump. Pressure drop across the filter with clean conditions shall not exceed .1 psi at 8 gpm with 150 SSU oil. The filter shall not incorporate a by-pass valve. It shall incorporate a visual element cleanliness indicator. In addition, the element shall be of metal construction. The system shall be equipped with isolation valves on either side so that the filter can be removed without draining the system.

3.4.7.2 Pressure Filter

A ten (10) micron (nominal) pressure filter shall be installed on the pressure side of the pump as shown on GE Yaw Schematic 47E382314. Pressure drop across the filter when clean shall not exceed 1 psi at 8 gpm of 150 SSU oil. The filter shall contain a non-collapsing, non-bypassing element of metal construction. Additionally the filter shall contain a ΔP switch which will close a set of contacts when a predetermined maximum pressure drop is reached. The element shall be capable of withstanding without damage or degradation a pressure drop of 3000 psi. The filter housing shall be designed for 3000 psig internal pressure. This filter shall also be equipped with isolation valves on either side so that the filter can be removed without draining the system.

3.4.8 SYSTEM PRESSURE LEVELS

Unless otherwise specified all components, fittings, sensing devices, and interconnecting piping shall be designed to operate with an internal pressure of 3000 psig. Exceptions are drain and suction lines, the reservoir and its accessory equipment which shall be designed for an operating pressure of 125 psig. All components shall be capable of withstanding a proof pressure test of 1.5 times the nominal pressure level without degradation of performance. The system and all components shall be capable of surviving an internal vacuum pressure of 10^{-3} mm Hg absolute.

3.4.9 LEAKAGE

There shall be no evidence of external leakage, under normal visual inspection and wipe testing, when the system is pressurized to normal operating pressure levels. All valves shall exhibit a maximum internal leakage of 1 drop per minute.

3.4.10 MATERIAL COMPATIBILITY

All materials of construction shall be compatible with the hydraulic fluid specified in Section 3.4.6.

3.4.11 LINE SIZES AND MATERIALS

All interconnecting tubing shall be sized for flow rates of 15 fps minimum and 30 fps maximum in accordance with accepted design practice. Material shall be ASTM A-269, type 304, 316, or other approved grades.

3.4.12 DRAINING AND VENTING

Provision shall be made for bleeding, draining and venting all circuits of the hydraulic power supply.

3.4.13 TUBING ASSEMBLIES AND FITTINGS

Tube connections and interfaces shall be welded wherever possible. Wherever welded tubing assemblies are not practical due to component availability or maintenance, Lenz O-ring fittings or equivalent shall be used.

3.4.14 PROTECTIVE COATING

All components of the hydraulic power supply subject to corrosion in the environment described in Section 3.4.1 shall be coated with a permanent protective finish.

3.4.15 STRUCTURAL SUPPORT AND INTERFACE

The hydraulic power supply will be mechanically attached to the upper yaw structure as depicted in Figure 1. Size and location of fasteners will be defined at a later date. The hydraulic component support structure shall be designed to support the components defined by this specification.

3.4.16 ELECTRICAL INTERFACES

480V power wiring shall terminate at the motor contactor. All other wiring shall terminate at an enclosed terminal strip with wire clamps capable of accepting up to AWG No. 10 size wire.

3.5 GENERAL DESIGN REQUIREMENT

3.5.1 AVAILABILITY

The Hydraulic Power Supply System shall be designed for a minimum availability of 99.7% over the service life, with a minimum MTBF of 4000 hrs. Special consideration shall be given to servicing and maintenance of critical areas.

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4.3 MINIMUM TEST PROGRAM (cont'd)

- b) External Leakage - "Wipe test" and visually observe all fittings, components and tubing joints for external leaks, with each element pressurized to nominal working pressure. No visible evidence of leakage shall occur for 2 hours.
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5.1 SHIPPING CONTAINERS

The shipping containers and method of shipment shall be approved by the General Electric Company prior to shipment of the Hydraulic Power Supply. All interface connections shall be capped or plugged to prevent entry of contaminants. After testing per 4.0, the system shall be drained and thoroughly cleaned. All strainers and filter elements shall be replaced.

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The vendor shall supply a Parts List, Service and Maintenance Manuals, Operating Instructions, Reproducible Drawings, List of Recommended Spares and Troubleshooting Instructions for the hydraulic power supply and its component parts. The vendor shall also supply procedures for shutdown, long storage period, and startup inspections.

MOD-5A WTG
47A380111
AUGUST 1983

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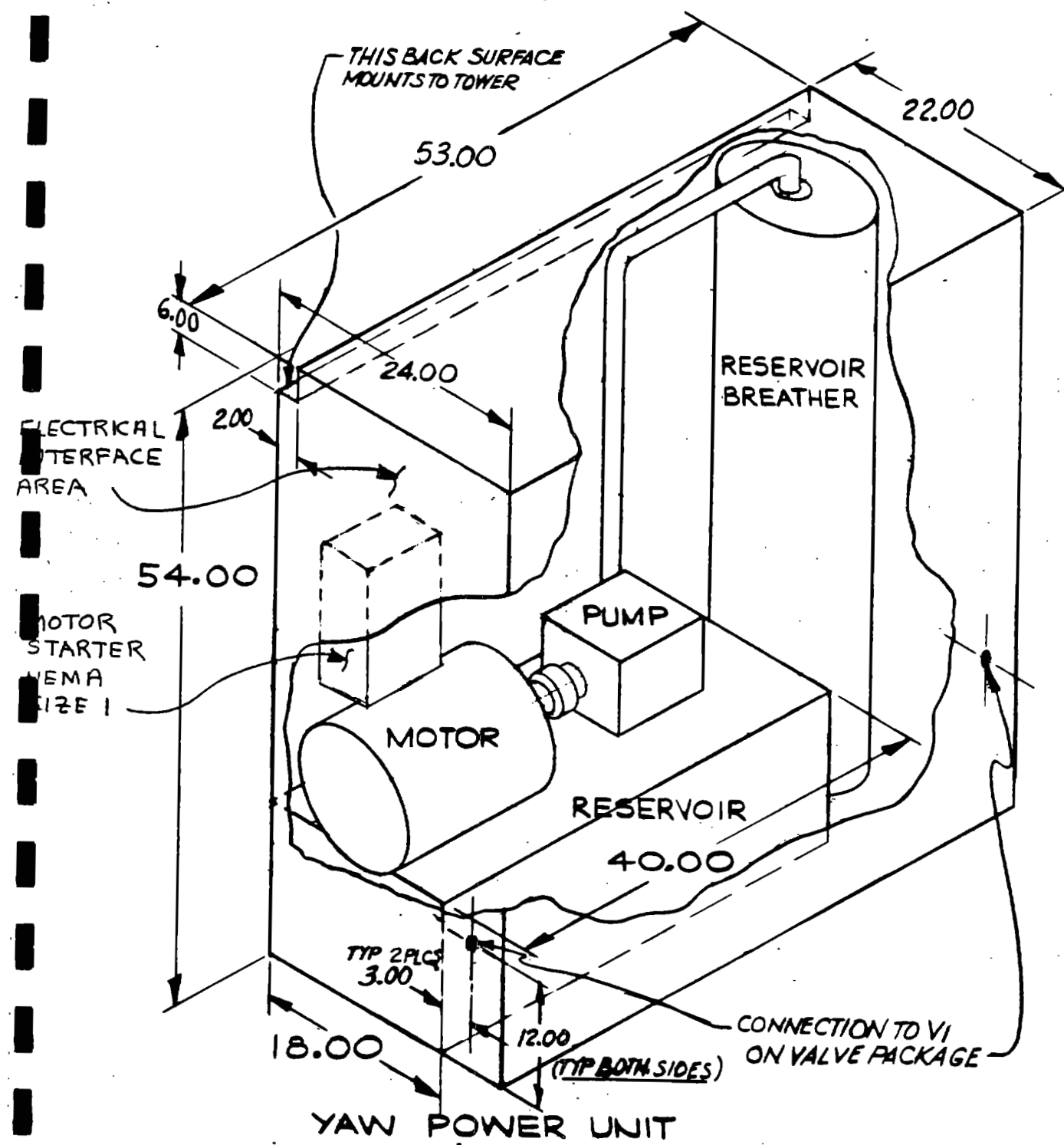


FIG. 1

47A380114

REV NO. A	TITLE	CONT ON SHEET 11	SH NO. 1
47A380114	FIRST MADE FOR		

GE MOD-0/5A AILERON TEST UNIT
TECHNICAL SPECIFICATION
AUGUST 16, 1983

REV "A"
AUG 83

REVISIONS

ISSUED REV "A" 9/19/83
A PER AN-1

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REVISION LOG

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Revision	Page No.	Paragraph Number(s) Affected	Rev. Date	Approval
A	1	1.1	8/31/83	<div style="border-left: 1px solid black; padding-left: 10px;"> REF 9/9/83 WCF 9/12/83 AH-1 </div>
A	1	1.2	8/31/83	
A	3	2.2	8/31/83	
A	4	2.3	8/31/83	
A	4	2.4	8/31/82	
A	7	4.5	8/31/83	
A	8	5.1	8/31/83	
A	8	5.2	8/31/83	
A	9	5.6	8/31/83	
A	10	5.7	8/31/83	
A	11	6.1	8/31/83	
A	12	6.2	8/31/83	
A	13	7.1	8/31/83	
A	14	8.1	8/31/83	
A	14	8.2	8/31/83	

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1.0 GEOMETRY

1.1 General

The required geometry of the test unit including the two (2) basic aileron configurations is specified in GE Drawing Nos. 47J382316 Rev. A and 47E382334 where dimensions on the latter must be ratioed to the chordlength and tip thickness ratio specified in the former. The general arrangement illustrating the installation of the test units on the MOD-0 WTG Test Machine is shown in Figure 1. GE will supply full size mylar definition of all airfoil contours at stations requested by the subcontractor. Finished external surface tolerances shall be as indicated on the referenced drawing.

1.2 Aileron Considerations

The required range of control deflections for the plain aileron is from $+5^{\circ}$ (positive toward high pressure side of the airfoil) to -95° (negative toward the low pressure side of the airfoil). The balanced aileron is required to have a range of control deflections from 0° to -95° . It is a goal (not a requirement) that the plain aileron be capable of deflections from $+15^{\circ}$ to -115° and the balanced aileron from 0° to -115° .

A vented configuration shall also be provided for the plain aileron where vent passages are provided between the upper and lower surfaces of the aileron aft of the hingeline. Total venting area shall be 15% of the aileron planform area (as a goal) distributed along the entire aileron span and in the forward 30% of the aileron chord. Minimum required venting area ratio shall be 10%. Individual vent holes shall have a minimum flow area of 1 sq.in. The vented configuration may be convertible to the unvented plain aileron configuration by sealing the venting passages with structurally acceptable tape on the external surface of the aileron or by other means. The conversion technique shall be easily accomplished as an in-air operation with the test unit installed in place on the MOD-0 WTG rotor.

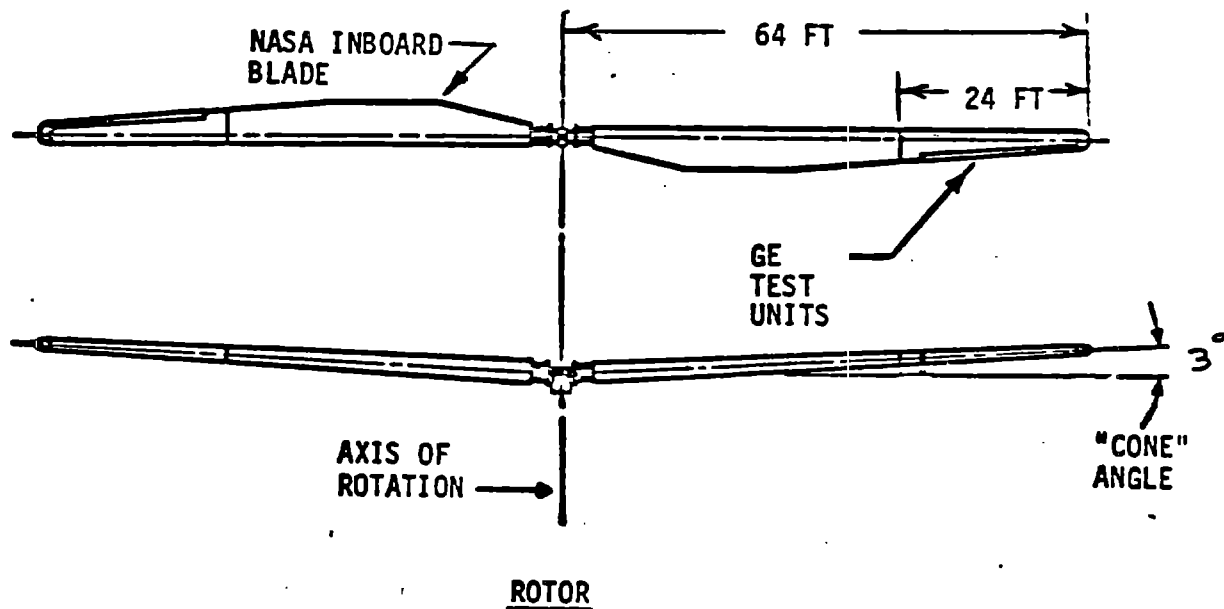
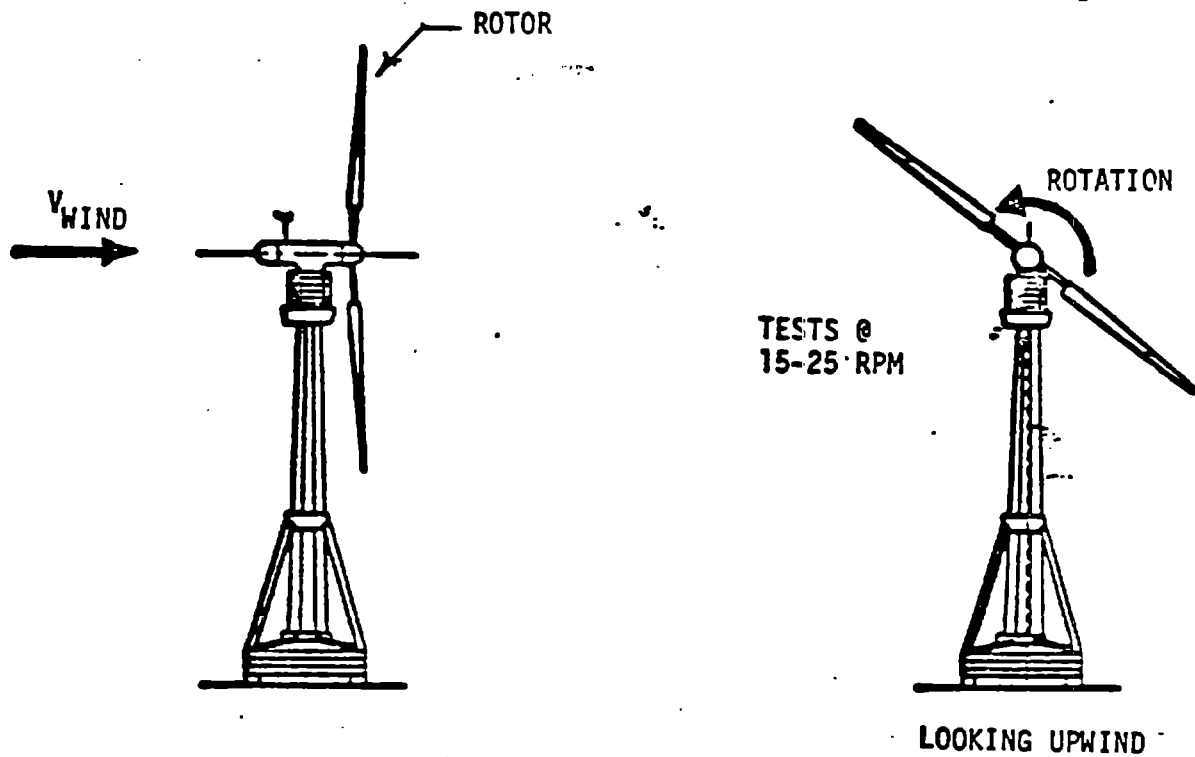


Figure 1. NASA MOD-0 WTG Plum Brook Test Machine

2.0 STRUCTURAL DESIGN CRITERIA AND CONSTRAINTS

2.1 General Criteria, Weight and Balance Requirements

The test unit design may be of any standard, industry-acceptable, design concept which will meet the load, actuator and instrumentation requirements specified below. The final test units, however, must not exceed 1000 lbs. weight (per unit) including all structural and other components. Lighter weight is desirable.

Individual weights of the two test units shall be the same within 5 lb. No absolute location for the Center of Gravity (CG) is specified; however, the location of the CG of the two individual test units shall be the same within 2 in. in both spanwise and chordwise directions. The weight and balance of the test units can be achieved by use of ballast weights and shall be accomplished at the vendor plant prior to shipment.

All external fasteners, rivets, etc., shall be flush with the airfoil/aileron surface. No steps or gaps shall exist between external surface skin sectors. Aileron hinges shall be flush or mounted below the surface.

2.2 Aileron Design Considerations

Aileron modifications required to change between the various configurations defined in Section 1.0 and GE Dwg. No. 47J382316 Rev. A shall be designed such that any hardware components which must be removed/installed shall weigh no more than 30 lb. (each piece) and have dimensions not exceeding 4 ft. length by approximately 2 ft. wide on any side (each piece). Fasteners, if required, for these changeable parts shall be no smaller than 1/4 in. diameter, driveable with a variable speed, reversible electric drill motor. Their use shall be minimized to facilitate ease of field installation and removal. All fasteners shall be of a vibration-locked design.

2.3 Design Margins

All design definition shall be based on maintaining a minimum factor of safety of 1.5 between maximum limit loads and the yield criteria for the material or device being designed.

Although no structural fatigue life requirement is defined, fatigue resistant engineering design approaches shall be employed. A minimum life of 1000 hours operation @ 25 RPM (i.e., 1.5 million rotations) with inspection of critical areas after every 200 hours of operation is desired. A minimum of 5 and maximum of 10 inspection hatches (approximately 6 in. x 6 in.) shall be incorporated in the design to provide visual access to those points in the structure where analyses have indicated critical high-stress areas exist for potential fatigue failures. The bending stress history at the interface (Station 481) with the NASA mating blade end will also be monitored and recorded during all test operations.

Any bearings, e.g., in the aileron actuation linkage, shall have a minimum life of 1 million equivalent rotations under design loads.

2.4 Allowable Deflection Under Load

Under maximum design loadings, flapwise (i.e., normal to the airfoil chordline) deflection of the tip relative to the interface Station 481 shall be less than 12 in.

As a goal, the maximum twist or roll-up of the aileron at any spanwise location under maximum operating loads shall be no more than 5% of the aileron deflection angle, or 1°, or whichever is greater. As a minimum requirement, aileron twist values shall not exceed those encountered with industry-standard aircraft design techniques proven acceptable for manned aircraft certification requirements.

3.0 AILERON ACTUATION SYSTEM

3.1 Hydraulic Actuation

The aileron system shall be actuated by means of a hydraulic system similar to that system used by NASA in earlier units and described in GE Dwg. No. 47D382374 and photographs of Attachment 1. It is desirable that identical hydraulic-servo, three-way, and flow-control valves and actuation cylinders be employed in the GE test units if consistent with specified loads, hinge moments, increased deflections, etc. Component definition is included in the reference drawing. Other standard hydraulic components may be defined by the contractor.

The hydraulic actuation subsystem shall, through an appropriate system of levers, cranks, etc., activate the aileron through the range of control deflections specified in Section 1.0. It shall also provide necessary forces and moments required to deflect the aileron, as required, against the deflecting moments due to the Failsafe Aileron Feathering Subsystem described below.

Actuation system components shall be contained in a bay between ribs at Stations 481.0 and 515.5. The test unit skin shall be fully removable in this area to provide easy access to actuation and measurement subsystem components, etc. The servo control valve (ABEX 410-1062) shall be mounted in the test unit such that its orientation relative to the rotational forces is the same as in the NASA Aileron Tip Units (Attachment 1).

It is required that the hydraulic system operate at a maximum supply pressure no greater than 2600 psi. However it is a goal that necessary hydraulic supply pressure be no greater than 1600 psi. Hydraulic lines shall be either stainless steel tubing or flexible hydraulic hoses which will meet all subsystem pressure and temperature requirements, etc. All connections shall be made with standard AN flare fittings and Voishan copper seals. Flex hoses shall be employed only

to interface with the NASA hydraulic supply/return lines and where motion is required. Flex hoses shall not exceed 3 ft. length and shall be tied down to prevent excessive motion in the rotational environment.

The aileron actuation system shall be interlocked or otherwise designed to prevent damage to hardware if the following operations are inadvertantly attempted:

- a) change of aileron deflection while the positive latching system (Section 3.5) is still engaged
- b) movement of the balanced aileron configuration to positive (+) deflection angles

3.2 Failsafe Aileron Feathering

A failsafe centrifugal actuation subsystem similar to that employed in the NASA Aileron Tip Unit (or an equivalent) for aileron feathering shall be incorporated in the GE test units such that the aileron is automatically forced to maximum negative deflection in the event of hydraulic and/or electrical subsystem failure. The subsystem shall force the aileron to full deflection at rotor speeds down to 5 RPM.

3.3 Positive Latching

A subsystem shall be incorporated to provide positive mechanical latching of the aileron to hold it at full negative deflection in the absence of all hydraulic, electrical and pneumatic power. The unlatching function shall be reliably accomplished hydraulically or electrically when tests are in progress. An equivalent latching subsystem was not included in the NASA aileron tip.

3.4 Interfaces

Interface requirements for hydraulic and electrical lines are defined in Section 5.0.

4.0 INSTRUMENTATION

4.1 Aileron Control Deflection

Aileron deflection shall be measured employing the same transducer model as used in original NASA test units.

4.2 Strain Gages

Four-arm bridges using 350 ohm gages (10 V excitation) shall be employed to measure:

- Chordwise Bending Moment
 - Flapwise Bending Moment
 - Aileron Control Force
- } Near Station 481.0

Two sets of strain gages shall be employed in all cases for full redundancy.

4.3 Angle-of-Attack Meter

An angle-of-attack sensor shall be supplied by NASA for installation on the leading edge of one of the test units. The sensor will be installed at a spanwise station approximately at aileron midspan. Exact spanwise location is not critical and may be selected to accommodate ease of installation on structure..

4.4 NASA Surface Pressure Measuring System

TBD

4.5 Instrumentation Cable Conduits

Provision shall be made for installation of cable conduit(s) 1 in. I.D. to bring future instrument cables from the test unit tip to interface Station 481. Cable routings shall be available both forward and aft of the main spar for this purpose.

5.0 INTERFACES

5.1 Mechanical Interface

The mechanical interface at the inboard end of the test unit shall be as specified by the Station 481 rib templates supplied by NASA and GE Drawing 47J382316, Rev. A.

The GE test units will be lifted with chordlines vertical for mating with the NASA interfacing blade ends. One test unit will have trailing edge up, the other will have leading edge up during these operations. The test units shall be compatible for lifting and handling techniques employing two six-inch wide straps for lifting each unit at two points. The design shall be compatible with lifting on either the leading edge or the trailing edge where, in the latter case, the lifting straps may be positioned at spanwise stations on the aileron. The contractor may supply lifting fixtures if necessary to meet this requirement.

5.2 Hydraulic Interface

The hydraulic lines from the NASA MOD-0 control system shall enter the GE test units through a hole in the interface rib (Station 481) as indicated in GE Dwg. No. 47J382316 Rev. A. The size and location of the hole shall be as specified on the NASA Station 481 rib templates. Three lines enter the test unit at this point:

- 1) Hydraulic Supply Line (Aileron Control) - 3/8" stainless steel tubing
- 2) Hydraulic Return Line (Aileron Control) - 1/2" stainless steel tubing
- 3) Pneumatic Supply Line (Not used) - 1/4" stainless steel tubing

All three lines extend approximately one foot through the Station 481 interface rib into the test unit.

All connections shall be standard AN flare connections with Voishan copper seals. Flexible hoses (consistent with pressure requirements, etc.), may be employed to interface with the NASA lines. These lines shall be tied down and kept to minimum length with maximum length of flex hose not to exceed 3 ft.

5.3 Electrical Interfaces

All electrical cables and wires (power, control, instrumentation) shall enter the GE test units through the same hole in the Station 481 interface rib as for hydraulic and pneumatic lines. All interfacing electrical cables and wires supplied by NASA at the end of their interface blade will provide approximately 4 ft. of "pigtail" length for connection in the GE test unit. All electrical interface connections shall be made on standard terminal strips to be supplied by GE/NASA. The terminal strips shall be mounted in the test unit by the subcontractor.

All electrical power requirements shall be satisfied by the 120 VAC lines supplied from the NASA interface.

5.4 Angle-of-Attack Meter

The NASA supplied device will be installed on the leading edge of one test unit. This interface (mechanical and electrical) will be defined in the future.

5.5 NASA Surface Pressure Measurement System

TBD

5.6 Instrumentation Cable Conduits

Provision shall be made to route all leads from the full-span instrumentation cable conduits (Section 4.5) to the location of the electrical terminal strips.

5.7 Lightning Protection

Provision shall be made to electrically connect the test unit metal structure to the lightning protection system in the NASA blade tip. This consists of a No. 4 electrical conductor 20 in. long which will penetrate the Station 481 interface rib approximately 6 in. forward of the trailing edge as indicated on the Station 481 rib templates.

6.0 DESIGN LOADS AND ENVIRONMENT

6.1 Loads

Design loads shall be comprised of the vector sum of loads from three sources:

- aerodynamic loads
- centrifugal loads due to rotation
- gravity loads

a) Aerodynamic Loads

Aerodynamic design loads are specified in Ref. 1. The limit loads specified in Figure S-1 and S-1b, Ref. 1, shall be the maximum limit loads for design of the basic structure of the test unit. These loads correspond to maximum anticipated loads during a hurricane and are consistent with an average differential pressure of 50 PSF acting over the entire surface. These limit loads shall be employed in evaluation of the tip deflection requirement. Where actual maximum surface pressures may be a critical design parameter, the detailed pressure distributions of Figures P-1 and P-2 shall be employed for basic airfoil and aileron surface pressures, respectively, where the local values so defined exceed 50 PSF. Note the spanwise variation of pressure defined on Pg. 2 of Ref 1.

b) Centrifugal Loads

The test units will be mounted on the tips of the NASA MOD-0 WTG rotor blades. The test units shall be designed to withstand all rotation-induced forces for rotational speeds to 30 RPM. The station numbers on GE Dwg. No. 47J382316 are the distances from the horizontal axis of rotation of the machine. The blades are also mounted at a "cone" angle of 3° as shown in Figure 1 so that rotational forces although primarily in the spanwise direction will also produce some small flapwise loads due to the rotation.

c) Gravity Loads

The test units will be subjected to alternating chordwise gravity loads due to their own weight on every revolution of the rotor. A small flapwise component may also be present due to the "cone" angle noted above. The magnitude of these loads will be determined by the final weight and CG location of the test unit. These loads shall be computed by the subcontractor and considered, as required, in the design of the test unit.

6.2 Environment

The test units will be operated in the open environment exposed to all weather conditions at the Plum Brook Test Site near Sandusky, Ohio. External surfaces shall be compatible with exposure to sun, rain, snow, sleet, etc., as encountered annually at the test site. Test unit temperatures may vary from a low of -20°F (cold winter days) to a high of approximately 120°F (hot day, exposed to bright, direct sunlight). All internal components shall be moisture-proofed, as required, to prevent failures due to humidity, condensation, etc.

Provision shall be made to design the system so that operation of the aileron failsafe-feathering and positive-latching systems (Section 3.2 and 3.3, respectively) will be reliable under potential icing conditions which may occur during winter test operations.

7.0 QUALITY CONTROL, TESTING AND CALIBRATION

7.1 Quality Control

The subcontractor shall supply GE with their quality control manual which will document their quality control plan for review and approval. The subcontractor shall work F.A.R. (Federal Aviation Requirements) which will, as manrated, be adequate for the present hardware.

7.2 Proof Testing

Both test units shall be proof tested. The entire assembly shall be structurally proof tested to limit and/or operating loads (below yield) prior to acceptance by GE. Hydraulic/pneumatic systems shall be proof tested to 150% of maximum design operating pressure. Final test criteria, loads, etc., will be defined and developed as the task matures. Testing shall, as a minimum, comprise a combined flap/chord bending of the main structure and normal and centrifugal loads on the aileron in addition to proof test of hydraulic/pneumatic systems. Tip deflection and aileron deflection requirements shall be verified. The aileron shall be operated under simulated maximum operating loads to demonstrate free operation of the control surface under these conditions. A proof test plan shall be generated by the contractor and approved by GE/NASA prior to testing. The contractor shall utilize Reference 2 as a guide for the required depth and scope of his structural proof test plan.

7.3 Calibration

Calibration of all test-unit instrumentation sensors (strain gages and aileron deflection angle transducer) shall be obtained as part of the test program. All sensors on both test units shall be calibrated.

8.0 REFERENCE DOCUMENTS AND DRAWINGS

8.1 Documents

- 1.) "Design Loads for the MOD-0/5A Test Article",
L. Feldman, GE PIR No. WTG-MOD-5A-83-277 Rev. A, 8/30/83
- 2.) "Structural Verification Test Results for the Aileron Blade Tip",
Dean R. Miller & Paul J. Sirocky, NASA LeRC, WEPO PIR No. 198, July 29,
1982

8.2 Drawings

- 1.) "GE MOD-0/5A Aileron Test Unit",
GE Dwg. No. 47J382316, Rev. A
- 2.) "MOD-5A Rotor Tip Configuration",
GE Dwg. No. 47E382334
- 3.) "GE MOD-0/5A Aileron Test Unit Hydraulic System Diagram"
GE Dwg. No. 47D282374
- 4.) "Aileron Controlled Blade Tip, MOD-0 100kW Wind Turbine",
NASA/Tanksley Dwg. Pkg.

9.0 ATTACHMENTS

- 1.) Photographic description of actuation component installation on NASA
aileron controlled blade tip.
(2) 8x10 photos

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FIRST MADE FOR

REVISION

FUNCTIONAL REQUIREMENTS
FOR A 7500 KVA VARIABLE SPEED
GENERATOR SUBSYSTEM
MOD-5A WTG
JULY 1983


Responsible Engineer

DATE: 7-11-83


Systems Engineering

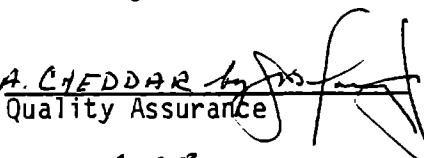
DATE: JULY 11, 1983


Engineering Manager


DATE: 7/11/83


Chief Engineer

DATE: 7/11/83


Quality Assurance

DATE: 7/12/83


WTG Integration

DATE: 7/11/83

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REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

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SECTION 1

1.0 SCOPE

This specification defines the functional performance, design and test requirements for a variable speed generator subsystem for wind turbine application.

Subsystem components defined are a generator and a converter. The generator is located in the nacelle at the top of the tower and the converter is housed in the electrical equipment building near the base of the tower.

SECTION 2

2.0 APPLICABLE DOCUMENTS

The following documents of the latest issue or as noted below form a part of this specification to the extent specified herein. In the event of conflict between this specification and the documents referenced herein, the contents of this specification shall be considered a superseding document.

2.1 GENERAL ELECTRIC DRAWINGS AND SPECIFICATIONS

- (TBD) Generator and Lube Mechanical Interface
- (TBD) Converter Mechanical Interface

2.2 OTHER STANDARDS

CSA (Canadian Standards Association)
(TBD)

ANSI (American National Standards Institute)
(TBD)

NEMA (National Electrical Manufacturers Association)
(TBD)

IEEE (Institute of Electrical and Electronics Engineers)
STD 472 Transient Voltage Protection
STD 519 Guide For Harmonic Control and Reactive Compensation Of Static Power Converters

MIL-STANDARDS
MIL-STD-461 Electromagnetic Emission and Susceptibility Requirements For The Control Of Electromagnetic Interference
MIL-STD-462 Test Methods For Electromagnetic Emission And Susceptibility

FEDERAL
FS-595A Finish Colors

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SECTION 3

3.0 REQUIREMENTS

3.1 SUBSYSTEM DEFINITION

3.1.1 GENERAL DESCRIPTION

The variable speed generator subsystem consists of:

- a) Generator
- b) Converter and Control

Interconnection and installation of the subsystem will be provided by the purchaser. Subsystem capabilities shall be to:

- a) Accelerate from 0 to 300 rpm motoring
- b) Synchronize
- c) Regulate system reactive power flow while generating with an output var regulation loop or a terminal voltage regulation loop
- d) Regulate air gap torque while generating from 960 to 1440 rpm
- e) Provide sequencing control and communication with purchaser equipment

3.1.2 SUBSYSTEM CONFIGURATION

Physical location of subsystem elements shall be as shown in Figure 3-1. Interconnection shall be as shown in Figure 3-2.

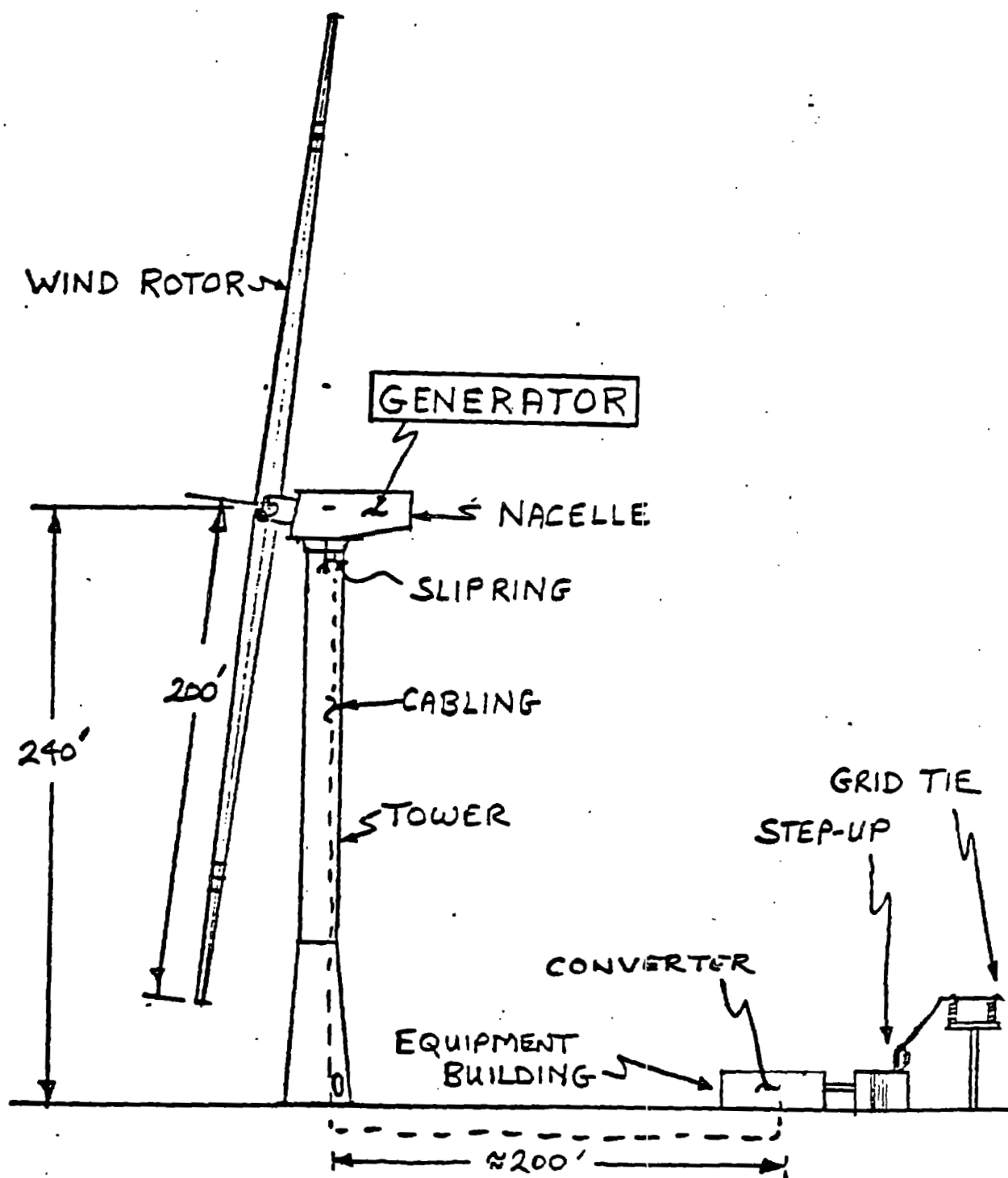


FIGURE 3 - 1

PHYSICAL LOCATION OF SUBSYSTEM

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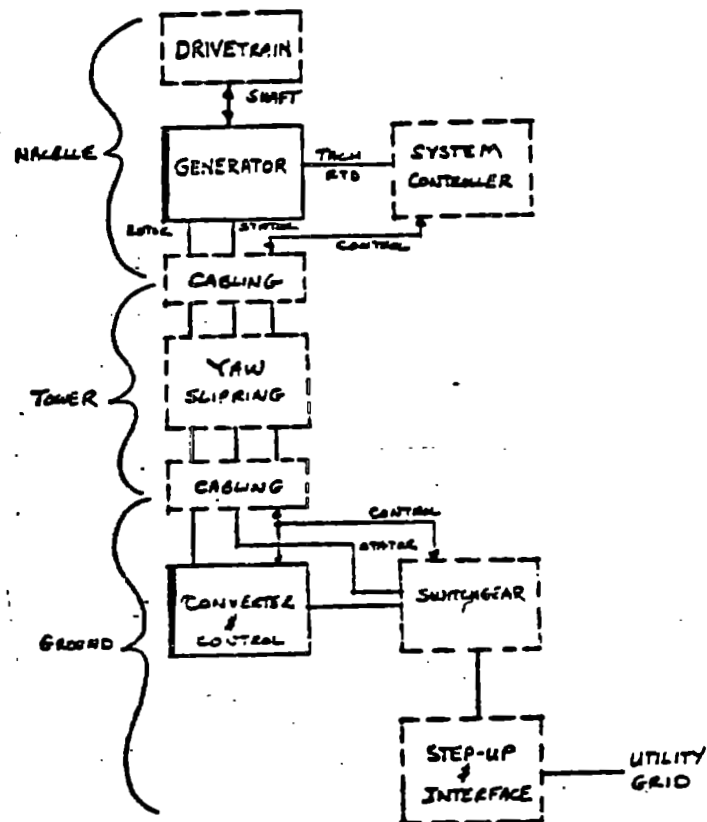


FIGURE 3 - 2

INTERCONNECTION BLOCK DIAGRAM

3.1.3 INTERFACE DEFINITION

3.1.3.1 Generator Mechanical Interfaces

The generator mechanical interfaces shall be per Table 3-1 and TBD Installation Drawing

TABLE 3-1
Generator Mechanical Interfaces

<u>Item</u>		
1	Interface Drawing	(TBD) Generator and Lube Mechanical Interface Drawing
2	Generator Installation	(TBD) Geometry Outline, TBD (Installation Drawing)
3	Shaft Coupling	Installation by TBD
4	Shaft Loads	Torque 38,500 \pm 3,850 Rating Ft-Lb (960 to 1440 RPM) Vertical 2000 \pm 400 lb Horizontal 0 \pm 200 lb Moment 1000 \pm 200 ft-lb
5	Turbine Inertia	350,000 lb ft ² @ 1200 RPM
6	Air Ducting	Per TBD (Installation Drawing)
7	Flood Lube System	Per TBD (Installation Drawing)
8	Mounting	Frame, supplied with generator, supports machine. Frame to be shimmed/grouted to bedplate and bolted in place.
9	Connections	Connection boxes suitable for 250 lb man to stand on. Conduit or cable duct may introduce up to 200 lb force in any direction.

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3.1.3.2 Generator Electrical Interfaces

The generator electrical interfaces shall be per Table 3-2 and TBD Installation Drawing.

TABLE 3-2

Generator Electrical Interfaces

<u>Item</u>		
1	Power	Compression connectors with lugs for purchaser connection. Wire size and quantity TBD.
2	RTD's	Three (3) lead type to terminal strip. Six (6) RTD connections required, others with leads coiled and marked in box. Purchaser connection via wire clamp suitable for #16 AWG or captive screw terminal strip.
3	Heaters	Four (4) lead connection to separate terminal strip. Purchaser connection via wire clamp suitable for #10 AWG or captive screw terminal strip.
4	Tachometers	Four (4) leads type to separate terminal strip. (Power, Power common, signal, signal return.) Purchaser connection via wire clamp suitable for #16 AWG. Tachometer pickups shall have locking plug connections.
5	Ground	Frame grounding location for purchaser lug connection.
6	Switches	Two (2) lead type to terminal strip. Purchaser connection via wire clamp suitable for #16 AWG or captive screw terminal strip.
7	Lube System	Power per item 3 above Sensors per item 6 above Lubrication system controls and sensors C-1 System on/off control S-1 Outlet pressure switch - low S-2 Sump level switch - low S-3 Fluid temperature switch - high S-4 Fluid temperature switch - low S-5 Filter differential pressure switch
8	Rotor Circuit	As required for implementation. Manufacturer to specify.

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3.1.3.3 Converter Mechanical Interfaces

Interfaces shall be per Table 3-3, and TBD Installation Drawing.

TABLE 3-3

Converter Mechanical Interfaces

<u>Item</u>		
1	Installation Outline	TBD Electrical Equipment Building TBD Installation Drawing
2	Mounting	Leveled on concrete slab with anchor bolt/stud holddown.
3	Connections	Cable/bus duct interface may impose 200 lb load in any direction. Power circuit connections via overhead duct. Control and signal leads shall be connected in a separate interface terminal area. Interconnection will be via overhead ducting.

3.1.3.4 Converter Electrical Interfaces

Interfaces shall be per Table 3-4, and TBD Installation Drawing.

TABLE 3-4

Converter Electrical Interfaces

<u>Item</u>		
<u>Power</u>		
P-1	Machine Side	Dual bus/lug connections Purchaser connection using two (2) 350 MCM, 5 KV Cables per Phase
P-2	Bus Side	Bus/lug connections. Purchaser connection to switchgear and step up transformer TBD.
P-3	Auxiliary	480 V, 4-wire, 30 Amp Purchaser connection via wire clamp suitable for #6 AWG or separate terminal strips.
P-4	Ground	Bus/lug connection to ground bus.
<u>Control - General</u>		
C-1	Discrete	Discrete signals to and from the wind turbine controller shall be two wire 120 VAC, maintained signal. The active (sending) end shall switch the source and the sensing end shall be high impedance and provided with (TBD) shunt resistance to avoid false indication due to switching device leakage current. Current range is 3A maximum, 20 ma minimum.
C-2	Analog	Analog signals to and from the wind turbine controller shall be twisted pairs, shielded 4-20 ma current loop. The active (sending) end shall be able to drive loop impedances from 0 to 1000 ohms. Signal receiver input impedance shall be 500 ohms approximately.
C-3	Tachometer	Tachometer pulse signals shall be TBD, to suit system arrangement
C-4	Potential Transformers	PT secondary connections shall be two wire suitable for 300 VAC transient duty.
C-5	Current Transformers	CT secondary connections shall be two wire suitable for 20 amp transient duty. Shorting bars shall be provided on the interface terminal strip. CTs only for converter use.

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TABLE 3-4 (cont'd)

Converter Electrical Interfaces

- C-6 Power Control Switchgear control signals shall be 48 VDC relay coil circuits. Purchaser will provide external 48 VDC. Dry contact switching suitable for 5 amp make and break shall be provided, with purchaser's control circuit providing circuit interruption.
- C-7 Connections All purchaser control connections shall be via wire clamp suitable for #12 AWG, or captive screw terminal strips.

Signals

- | | | |
|--------------|--------------------------|------------------|
| S-1 | "Converter Ready" | Per C-1, |
| S-2 | "Turbine Ready" | Per C-1, |
| S-3 | "Start/Motor" | Per C-1, |
| S-4 | "Synchronize/Generate" | Per C-1, |
| S-5 | "Torque/Speed Reference" | Per C-2, |
| S-6 | "VAR/Volt Reference" | Per C-2, |
| S-7 | "Lockout Trip" | Per C-6 |
| S-8 | "Stator Voltage" | Per C-4, 3 Phase |
| S-9 | "Bus Voltage" | Per C-4, 3 Phase |
| S-10 | "Stator Current" | Per C-5, 3 Phase |
| S-11 | "Bus Current" | Per C-5, 3 Phase |
| S-12 to S-20 | | Spares |

3.1.4 OPERATIONAL DESCRIPTION

3.1.4.1 Duty Cycle Description

The annual design wind cumulative probability and resultant output power cumulative probability are shown in Figure 3-3. Annual start-stop cycles are 1200; approximately three (3) per day.

A typical operating cycle consists of:

- a) Accelerate from 0 to 300 rpm motoring - one (1) minute
 - b) Shaft driven by turbine to 960 rpm - two (2) minutes
 - c) Synchronize at 960 rpm (synchronize ability from 960 to 1440 rpm)
 - d) Operate at 1080 - 1140 rpm at air gap torques from 0 to 1.0 per unit, externally referenced - 60 minutes
 - e) Accelerate under wind turbine system control to 1380 rpm - 0.5 minute (external reference reduces air gap torque to provide acceleration)
 - f) Operate at 1320 - 1440 rpm at air gap torques from 0 to 1.10 per unit, externally referenced - 60 minutes
 - g) Decelerate under wind turbine system control to 1140 rpm - 0.5 minute (external reference increases air gap torque to provide deceleration)
 - h) Repeat d) through g) above one to four times
 - i) Hold air gap torque at 1.0 per unit while decelerating to 960 rpm, externally referenced - 0.5 minute
 - j) Reduce shaft torque to zero - 0.2 minute
 - k) Externally reduce speed by turbine control to 0 rpm - two (2) minutes
- 1 per unit synchronous speed = 1200 rpm
- 1 per unit air gap torque = 38,500 ft-lb

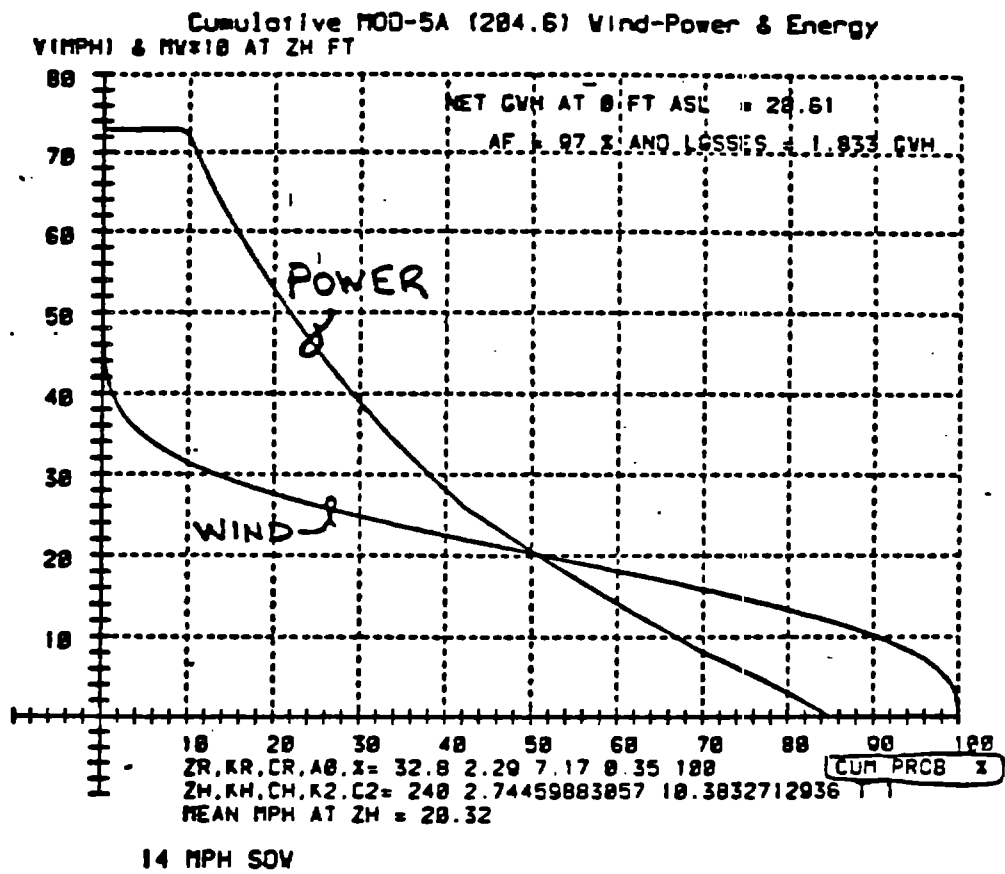


FIGURE 3-3

WIND AND POWER DISTRIBUTION

3.2 CHARACTERISTICS

3.2.1 GENERATOR

3.2.1.1 Generator Characteristics

The generator shall have the characteristics shown in Table 3-5. Standard ratings shall be based on appropriate CSA, ANSI, and NEMA standards. The supplier shall identify the standards utilized.

TABLE 3 - 5
GENERATOR CHARACTERISTICS

<u>Item</u>	
1	Rating 5000/7500 KW at 960/1440 rpm 38,500 ft-lb air gap torque
2	Frame Open, drip proof
3	Direction of Rotation Rotation CCW looking at drive end
4	Insulation Class F with Class F rise at rating (105°C rise over 40°C ambient temperature)
5	Voltage 4160 Volt L-L, 60 Hz, 3 Phase All phase winding leads and neutral must be made available to facilitate external WYE configuration.
6	Grounding Stator neutral will be high resistance grounded by purchaser to limit phase to ground fault current to less than 0.2 pu. Shaft to frame grounding brushes shall be installed at bearings.
7	Cooling Self ventilated via shaft mounted fans. Provision made for purchaser installed intake and exhaust ducting. Purchaser will provide external fan for low speed motoring duty cooling, if required.
8	Mounting Per paragraph 3.1.3.1. Up to 7° inclination from horizontal with drive end high.

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TABLE 3 - 5 (cont'd)

GENERATOR CHARACTERISTICS

<u>Item</u>	
9	Bearings
10	Flood Lube
11	Operation
12	Overspeed
13	Losses
14	Overload
15	Impedances
16	Maintenance

Double bearings, self-lubricated, journal type. Drive end bearing shall have thrust capability sufficient to restrain 1.2 times rotor weight force component due to 7° inclination, and radial capability per paragraph 3.1.3.1. The generator bearings shall be provided with a means of transient self-lubrication to avoid damage on coast down from 1440 rpm at 10 rpm/second without flood lubrication.

Purchaser installed flood lubrication system. Capped inlet and outlet piping and appropriate bearing openings shall be provided. A separately mounted flood lubrication system package shall be provided for continuous supply of bearing lubrication fluid. The skid or tank mounted unit shall consist of a reservoir heater, filter, pump, pump motor, motor starter, sensors, and electrical and hydraulic interconnections. Power, control, and sensing devices shall be per paragraph 3.1.3.2.

Per paragraph 3.1.4 duty cycle. Basic operation modes are with motor torque from 0 to 300 rpm, and with constant air gap torque from 960 to 1440 rpm.

1700 rpm mechanical overspeed design (118% of 1440 rpm)

No load at synchronous speed, 100 kW maximum losses. Rated output at 1440 rpm, 300 kW maximum losses. Computed losses shall be specified for 0, .25, .50, .75, 1.0 pu rating air gap torque conditions at 960, 1200, and 1440 rpm.

Shafting capable to withstand 2.5 pu rated air gap torque conditions for 100 times over life time.

The manufacturer's standard design practices shall be used.

Design shall be suitable for a six (6) month or more periodic inspection and maintenance interval. Brushes shall have twelve (12) month minimum mechanical design life. Bearings shall be replaceable without rotor removal.

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TABLE 3 - 5 (cont'd)
GENERATOR CHARACTERISTICS

Item

- | | | |
|----|-----------------|--|
| 17 | Life | Expected design life, with periodic maintenance shall be 30 years. |
| 18 | Materials | Construction materials shall be inherently corrosion resistant or protected from corrosion due to exposure to airborne moisture and salt in cooling air per paragraph 3.2.1.3. |
| 19 | Altitude | Per paragraph 3.2.1.3 |
| 20 | Weight, Size | As identified on Mechanical Interface Drawing (TBD). |
| 21 | Turbine Inertia | Motoring duty shall be based on the turbine inertia defined in paragraph 3.1.3.1. |

Accessories

- | | | |
|-----|------------------------------|---|
| A-1 | Connection Boxes | Oversize connection boxes shall be provided, mounted as shown on Mechanical Interface Drawing (TBD) to house both rotor and stator circuit surge arrestors and surge capacitors. Separate connection boxes shall be provided for instrumentation and heater connections |
| A-2 | Surge Protection
(Option) | Stator and rotor circuits (if applicable) shall be provided with
5.1 KV lightning arrestors and 0.5 MFD wave shaping capacitors connected from each phase to the machine frame, mounted and connected in terminal boxes. |
| A-3 | Winding RTDS | Each phase of the stator windings shall have two (2) 10 ohm copper 3 lead Resistance Temperature Detectors installed and wired to the instrument connection box. |
| A-4 | Bearing RTDS | Each bearing shall have one (1) 10 ohm copper 3 lead Resistance Temperature Detector installed and wired to the instrument connection box. |

TABLE 3 - 5 (cont'd)

GENERATOR CHARACTERISTICS

Item

- | | |
|------------------------|--|
| A-5 Tachometer Pickups | The rotor shaft shall be supplied with a toothed wheel having 120 (approximately) teeth. Two pulse generator pickups shall be mounted adjacent to the wheel and wired to the instrument connection box. One pickup is for converter control use and the other is for purchaser use. The purchaser use pickup shall supply an approximately 5 volt square wave output with purchaser provided excitation. The converter control pickup shall provide a signal level suitable for transmission over 600 feet of coaxial or twisted shielded pair wiring. |
| A-6 Space Heater | An anti-condensation heater, suitable for continuous energization, shall be mounted and wired to the instrumentation terminal box. 208 VAC, 4 wire, 3 Phase, 60 Hz power at 3 kW maximum will be provided by purchaser for balanced load heater operation. |
| A-7 Ground Pad | An unfinished, flat, frame connection location with two (2) tapped or clearance holes with back access shall be provided for attaching a ground connection with 1/2-13 hardware. This shall be located near a lower side corner of the frame. |
| A-8 Vibration Switches | Each bearing shall have a vibration sensor (switch type) of the supplier's recommended type, mounted and wired to the instrumentation connection box. |

3.2.1.2 Generator Parameters

The supplier shall provide the purchaser with the data shown in Table 3-6 within ten (10) weeks of receipt of order.

TABLE 3 - 6
GENERATOR PARAMETERS

<u>Item</u>	
1	Weight (lb) and Center of Gravity location
2	Rotor inertia (lb-ft ²) and shaft sketch
3	Breakaway torque (lb-ft)
4	Cooling air requirements (SCFM, psi drop, temperature rise)
5	Bearing lube requirements (GPM, viscosity for flood lube)
6	Losses calculation per Table 3-5, item 15
7	All machine impedances shall be specified
8	Air gap saturation characteristics (curve)
9	Outline drawing showing installation handling and shipping package details and access requirements for installation and maintenance
10	Connection diagram; power and instrumentation elementary diagrams
11	Summary parts list and recommended spare parts list
12	Draft instruction book (final with delivery) including maintenance requirements
13	Auxiliary power requirements

3.2.1.3 Generator Environmental Conditions

The generator will be housed within an unheated, insulated metal enclosure at the top of a 240 foot tower. Ambient temperatures during operation will range from -20°C to +40°C. Survival (non-operating) ambient temperatures will range from -40°C to +50°C. Relative humidity will be 10% to 90%, noncondensing.

Ratings apply for altitudes from sea level to 3300 ft. Application may be at up to 7000 ft with higher ambient temperatures in which case appropriate derating will be used for cooling and insulation properties.

Cooling air will be mechanically filtered by purchaser to remove most airborne moisture, salt, and particulates. For corrosion analysis assume 0.005 PPM maximum salt content in intake air after filtration for sea coast installation.

Vibration while operating may be up to ± 0.25 g in any direction at frequencies less than 5 Hz.

3.2.2 CONVERTER

3.2.2.1 Characteristics

The converter shall have the characteristics shown in Table 3-7. Standard ratings shall be based on appropriate CSA, ANSI, and NEMA standards. The supplier shall identify the standards utilized.

TABLE 3-7

CONVERTER CHARACTERISTICS

<u>Item</u>		
1	Rating	to conform with 7500 KVA system rating
2	Machine Connection	Coordinated with generator characteristics
3	Enclosure	Indoor NEMA 1 type with front door access to all electronic components, and rear panel access to connections.
4	Frequency	Line connection 60 Hz.
5	Harmonics	Converter control and connection shall minimize current harmonics on the 60 Hz system, consistent with economic control.
6	Harmonic Filters	Purchaser will provide 60 Hz system filtering consistent with IEEE Standard 519.
7	Reactive Power	Converter reactive power duty will be minimized by use of 60 Hz system filter and power factor correction capacitance. System operation will be at 0.98 to 1.0 pf.
8	Cooling	A dual fan shall be provided for circulation of ambient air. Either fan shall be capable of cooling from rated conditions. Fan control shall be provided for alternating operation on startup and shift to other fan on loss of air flow during operation.
9	Fault Protection	Power modules shall be fused to prevent module permanent faults from propagating damage.
10	Control	Per paragraph 3.2.2.4. Basic control mode is independent control of machine air gap torque by power regulation and control of 60 Hz bus reactive power or voltage.
11	Losses	No load, with control and fan loads, 10 kW maximum. Rated conditions, 25 kW maximum

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TABLE 3-7 (cont'd)
CONVERTER CHARACTERISTICS

<u>Item</u>	
12	Maintenance
13	Diagnostics
14	Reliability
15	Life
16	Materials
17	Altitude
18	Space Heater
19	Grounding
20	Bus Work

Design shall be suitable for a six (6) month or more periodic inspection and maintenance interval. Control and power elements shall be of modular construction and replaceable from the front of the unit.

Light indicators and local logic devices shall be provided to aid in rapid fault diagnosis to maximize availability.

The allocated reliability goals for the converter and control assembly are:
Mean Time Between Failures
Requiring Maintenance - 9,000 hours
Mean Time to Repair - 2 hours
(with spare parts on hand)

Expected design life, with periodic maintenance shall be 30 years.

Construction materials shall be inherently corrosion resistant or protected from corrosion due to exposure to airborne moisture and salt in cooling air per paragraph 3.2.2.3. Circuit boards should be conformal coated where possible for general contamination protection.

Per paragraph 3.2.2.3

An anti-condensation heater, suitable for continuous energization shall be mounted and wired in the bottom of each equipment section. 208 VAC, 4 wire, 3 phase, 60 Hz power at 2 kW maximum will be provided by purchaser for balanced load heater operation.

A ground bus shall be run through all equipment sections and have a readily accessible purchaser connection.

Bus bar shall be of manufacturers standard construction. Connections shall be immune to the effects of zero to full load cycling.

TABLE 3-7 (cont'd)
CONVERTER CHARACTERISTICS

Item

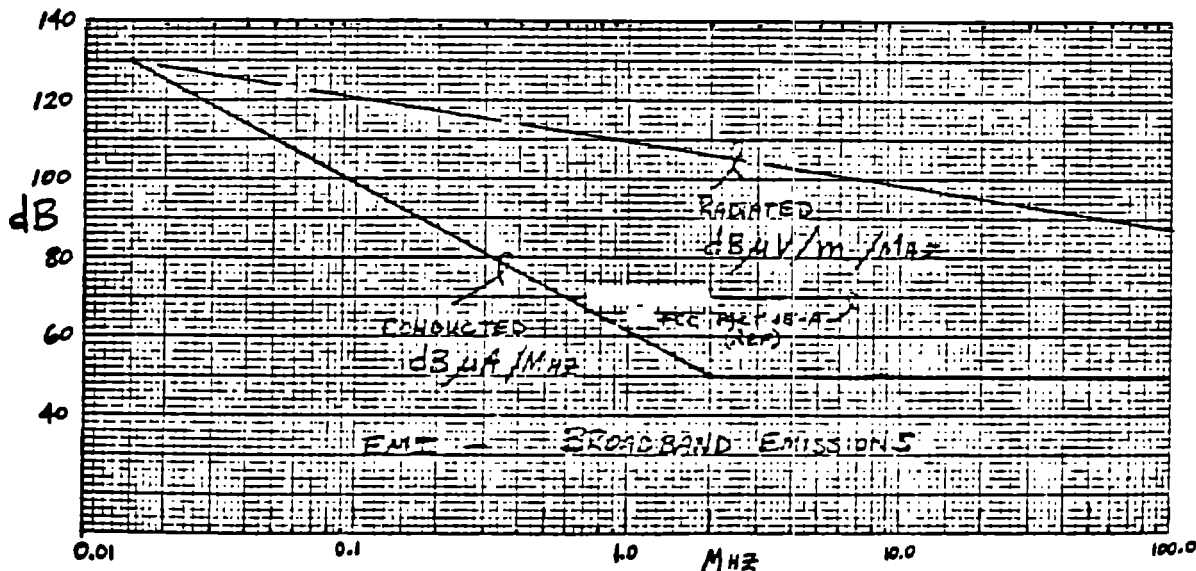
21 EMI

The converter and its controller shall not produce conducted or radiated signals that interfere with commercial electromagnetic devices. The converter and its controller shall not malfunction where a portable communication device with up to 5 watt transmitter power is operated within 10 feet with cabinet doors closed.

IEEE STD 472 surge requirements shall be provided on external connection points. Measurement of conducted and radiated electromagnetic emissions using procedures of MIL-STD-462 may be performed by the purchaser. The supplier shall provide representative data on his equipment. Measured data shall be less than the values shown in Figure 3-5, from MIL-STD-461.

3.2.2.2 Converter Parameters

The supplier shall provide the purchaser with the data shown in Table 3-8 within ten (10) weeks of receipt of order.



EMI ENVELOPE

FIGURE 3-5

TABLE 3-8

Converter Parameters

Item

- 1 Weight (lb)
- 2 Outline drawing showing installation and handling and shipping package details
- 3 Elementary and connection, power, instrumentation, control diagrams.
- 4 Cooling air requirements (SCFM, psi drop, temperature rise)
- 5 Losses calculation per Table 3-7, Item 14
- 6 Harmonic current calculations for rated, and near synchronous conditions through the 25th harmonic with typical impedance.
- 7 Summary parts list and recommended spare parts list
- 8 Draft instruction books (final with delivery) including maintenance requirements
- 9 Auxiliary power requirements

3.2.2.3 Converter Environmental Conditions

The converter will be housed within a building at grade level. Ambient temperatures during generation will range from 0°C to +40°C. Survival (non-operating) ambient temperatures will range from -40°C to +50°C. 10% to 90% humidity, non-condensing.

Ratings apply for altitudes from sea level to 3300 ft. Applications may be at up to 7000 ft with higher ambient temperatures in which case appropriate derating will be used for cooling and insulation properties. Cooling air will be mechanically filtered by purchaser to remove most airborne moisture, salt, and particulates. For corrosion analysis assume 0.005 PPM maximum salt content in intake air after filtration for sea coast installation. Cooling air will have a dew point sufficiently below ambient temperature to avoid condensation.

3.2.2.4 Converter Control

3.2.2.4.1 General

The converter control shall use proven components and assemblies where available. Bandwidth of the converter, generator, and control shall be as broad as practical with a goal of 80 radians/sec or higher equivalent first order lag (-3 dB, -45°).

Slue rate of the control response to changes in analog reference signals shall be limited by the control to 50%/second full scale in response to a step input.

3.2.2.4.2 Control Modes

Basic operating modes of the control are:

- Initialization
- Motoring
- Synchronization
- Torque regulation
- Reactive power regulation
- Shutdown
- Fault monitoring

Signals in the following paragraphs are shown on Paragraph 3.1.3.4

3.2.2.4.2.1 Initialization. The initialization mode occurs on converter control power-up. All outputs shall power-up to an off-state. The converter firing control shall be configured to a non-conduction state. Control power will be applied before 4160 volt line power is connected. Next, the control shall check for faults appropriate to a non-operating state. If no faults exist, then send a "converter ready" to the turbine control, and wait for further commands. If a fault exists, wait for repair.

3.2.2.4.2.2 Motoring. On receipt of a "start/motor" command,

- a) check for "Turbine Ready"
- b) turn on cooling fan and check air flow
- c) using the "Torque/Speed" analog reference, with overriding current limit, volts/hertz limit, and frequency limit, control converter operation regulating speed to cause the generator to accelerate from 0 to approximately 300 rpm
- d) at the upper end of the permissible speed range, wait for removal of the "Start/Motor Command"
- e) on "Start/Motor" command removal, slue rotor current to zero, independent of the "Torque/Speed" reference, then
- f) hold converter in a non-conducting mode and wait for "Synchronize/Generate" command. The turbine control will accelerate generator shaft speed to the 960 to 1440 rpm generating range.

NOTE: If the converter system is capable of motoring/generating operation at generator speeds from 300 to 1440 rpm with switchgear operation, the motoring and subsequent synchronization and generating modes may be merged into a single "motor/generate" mode utilizing the "torque/speed" analog reference as a double ended (\pm) torque signal.

3.2.2.4.2.3 Synchronization. On receipt of a "sync/generate" signal,

- a) Check for generator speed between 960 and 1440 rpm. If outside this range, wait until range is reached.
- b) After the stator tie is closed, operate simultaneously in both torque regulation and reactive power regulation modes.

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3.2.2.4.2.4 Torque Regulation

- a) Using the "Torque/speed" analog reference, regulate air gap torque.
- b) If reference torque transiently exceeds system rated capability, automatically limit torque to 110% of rated system capability.
- c) Wait for removal of "sync/generate" command.

Torque regulation shall achieve $\pm 1\%$ of rated air gap torque within one (1) second after a 20% step change in reference with shaft slue rates of up to 0.05 pu/second relative to synchronous speed. Range is -20% to +120% of rated torque.

3.2.2.4.2.5 Reactive Power Regulation

- a) Using the "Var/Volt" analog reference, regulate 4160 volt bus reactive power.
- b) If the reference Var value exceeds system capability due to rotor circuit KVA or stability limits, automatically limit Var regulation as necessary to maintain torque regulation. Simultaneous regulation is required, but torque regulation has higher priority when limiting conditions are reached.
- c) Wait for removal of "sync/generate" command.

Reactive power regulation shall achieve $\pm 1\%$ of system KVA rating within one (1) second after a 20% step change in reference with shaft slue rates of up to 0.05 pu/second relative to synchronous speed. Voltage control shall be a switch selectable optional regulation mode. Ranges are $\pm 10\%$ of 7500 KVA or 4160 Volts, depending on mode.

3.2.2.4.2.6 Shutdown. Shutdown is initially the same as the generating condition. The "Torque/Speed" reference will be ramped up to maximum value at 5%/second and shaft speed will be reduced by the turbine control.

3.2.2.4.2.6 Shutdown. (continued)

- a) When generator speed reaches approximately 980 RPM, the turbine control will ramp the "Torque/Speed" reference to zero at 5%/second while externally regulating turbine speed, then
- b) the turbine control will remove the "Sync/Generate" command.
- c) On "Sync/Generate" command removal, the converter control shall automatically regulate stator watts and stator Vars to zero, regardless of analog reference values.
- d) Bring converter to a non-conducting state
- e) The turbine control will bring the generator speed to zero.
- f) When speed is below 60 rpm and when temperature is acceptable or after a time delay, turn off cooling fan
- g) Wait for a "Start/Motor" command

3.2.2.4.2.7 Fault Monitoring. The converter control shall monitor converter and turbine operation for at least the following faults:

- a) overpower - stator, motoring or generating
- b) overpower - rotor, motoring or generating
- c) converter overcurrent
- d) bridge fault
- e) control malfunction
- f) control power loss
- g) cooling air loss
- h) phase unbalance
- i) overspeed beyond 1500 RPM
- j) turbine control ready signal
- k) over/under voltage

3.2.2.4.2.7 Fault Monitoring. (continued)

- 1) uncommanded tie breaker trip

For items i) and j), the converter control shall automatically ramp the torque reference used for torque regulation to maximum value until generator speed goes below 960 RPM, then continue as if in the shutdown mode following a "Sync/Generate" command removal.

For item g), the converter control shall turn on the second cooling fan and if cooling air flow recovers, continue operation.

For all faults but g), the converter control shall remove the "Converter Ready" signal to the turbine control which will cause shutdown initiation. If a cooling air fault g) is not cleared by operation of the second fan, then remove the "Converter Ready" signal.

For permanent faults requiring maintenance action, the converter control shall open the stator tie circuit breaker via the "Lockout" relay.

3.3 FINISH

Finish paint properties and color shall be per Federal Standard No. 595A:

- | | |
|--------------|------------------------|
| a) Generator | Semigloss Blue (25177) |
| b) Converter | Semigloss Blue (25177) |

The supplier shall provide information on finish paint materials and application methods in order to permit field touch-up.

3.4 MARKING

a) Generator

Stamped metal nameplates shall be secured to the machine frame showing relevant data on machine rating and manufacturer. Additional nameplates shall indicate rotation, stator connections, and rotor connections. A weatherproof terminal diagram and schematic shall be affixed to the inside cover of the instrumentation box. All leads shall be marked as noted on the connection diagrams.

b) Converter

Stamped metal nameplates shall be secured to the enclosure showing relevant data on unit rating and manufacturer. A weatherproofed elementary diagram book, showing connections, shall be supplied in a pocket affixed to the inside cover of the control compartment door. All terminal strips shall have identification of strip and terminal number clearly marked. All leads and devices shall be marked as noted on the connection diagrams.

SECTION 4

4.0 QUALITY ASSURANCE

4.1 DESIGN MANUFACTURING AND TEST FLOW PLAN

The supplier shall submit a Design, Manufacturing and Test Flow Plan showing the basic design operations, manufacturing operations, reviews, and production tests for General Electric - AEPD review and establishment of inspection points. Long lead items shall be identified.

4.2 DESIGN REVIEWS

An informal design review shall be conducted at the completion of design, prior to fabrication. Two informal subsystem test reviews shall be conducted; one after procedures are documented prior to the test, and a second after the test to review results.

4.3 GENERAL ELECTRIC INSPECTION

General Electric shall maintain awareness of the supplier's quality assurance with respect to the material to be furnished under this specification. Where inspection points have been established per paragraph 4.1, the supplier shall notify General Electric - AEPD forty-eight (48) hours in advance of the time when inspection is to be conducted.

4.4 PRODUCTION TESTS

4.4.1 GENERAL

The supplier shall perform standard production tests on all equipment and supply test data measurements where established per paragraph 4.1.

4.4.2 GENERATOR

Generator production tests shall include at least:

- a) High potential test
- b) Insulation resistance test
- c) Rotor balance
- d) No-load loss measurement (motor conditions)
- e) Phase sequence
- f) Connection continuity, conformance to diagram
- g) Dimensional check, conformance to installation drawings
- h) Visual check for finish defects

4.4.3 CONVERTER

Converter production tests shall include at least:

- a) Control wiring insulation megger
- b) Connection continuity, conformance to diagram
- c) Control functional check
- d) Dimensional check, conformance to installation drawings
- e) Visual check for finish defects

4.5 SUBSYSTEM TEST

4.5.1 GENERAL

A subsystem test shall be performed on first hardware to demonstrate the capabilities of the various components with respect to requirements, obtain engineering data on operation, calibrate sensors, and generally shake down the equipment.

4.5.2 SUBSYSTEM EQUIPMENT

Generator

Converter and Control

4.5.3 WIND TURBINE EQUIPMENT

Preferred

Switchgear Assembly with
Circuit Breakers, Relays,
Instrument Transformers,
Transducers, etc.

Turbine Controller with Wind
Turbine Simulator

Harmonic Filters and
Power Factor Capacitors

Optional (If preferred items unavailable)

Switching Devices and Instrument
Transformers

Test Switchbox with Manual Analog
Signal Settings

Nothing

4.5.4 TEST EQUIPMENT - SET-UP

- Variable speed drive motor and control capable of 0-1500 RPM operation at a shaft torque level of at least 13,500 ft-lb (35% of generator rating).
- Grid interface transformer with connection at 4160 V, 60 Hz, 3-Phase, 3500 KVA or higher capability
- Anchors for securing generator and drive motor
- Test couplings for connection of generator shaft to drive motor shaft
- Interconnecting power cabling

4.5.5 INSTRUMENTATION

The test instrumentation shall be sufficient to sense and record system performance parameters. A detailed instrumentation plan shall be prepared and approved prior to test.

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4.5.6 TEST REQUIREMENTS

A detailed test plan and schedule shall be prepared and approved prior to implementing test hardware. The following functions shall be tested.

- a) Motoring mode
- b) Synchronization at various accelerations
- c) Torque regulation at various accelerations and speeds
- d) Var regulation at various accelerations and speeds
- e) Calibration of switchgear transducers (if available)
- f) Harmonic current measurement at various speeds and converter power levels
- g) Generator bearing operation at 7° incline (actual or simulated)
- h) Measurement of lubrication and air cooling flow and temperatures
- i) Shutdown on loss of power
- j) Mechanical overspeed of generator

SECTION 5.0
PREPARATION FOR DELIVERY

The manufacturer shall submit a statement detailing the normal practice of packaging and method of delivery for continental and export destinations for approval by:

General Electric Company
Advanced Energy Programs Department
P.O. Box 527
King of Prussia, PA 19406

The method and destination will be identified two (2) months prior to shipment.

5.1 DOCUMENTS

- | | |
|--|------|
| o Certified detailed outline drawing | a, b |
| o Connection diagrams | a, b |
| o Complete instructions with parts list | b |
| o Detailed summary or equipment list | b |
| o Three (3) certified copies of test data | b |
| o Items in paragraph 3.2.1.2, 3.2.2.2, 3.2.3.2 | a |

5.1.1 DOCUMENT SUBMITTAL

Documents marked "a" shall be submitted for examination or approval within ten (10) weeks of order by sending two (2) copies to General Electric Company, Advanced Energy Programs Department, MOD-5A Engineering, P.O. Box 527, King of Prussia, PA 19406. Approval or comments will be returned within two (2) weeks of receipt.

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5.1.1 DOCUMENT SUBMITTAL (cont'd)

Documents marked "b" shall be supplied with shipment. One (1) mylar reproducible and ten (10) copies of each drawing shall be supplied. Twelve (12) copies of instruction books shall be supplied. In addition, one copy of all documents shall be enclosed with shipment.

Documents marked "a, b" shall meet submittal requirements of both "a" and "b".

REV
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TITLE

47A380116

CONT ON SHEET *ii*

SH NO. *i*

FIRST MADE FOR

REVISION

FORGING MATERIAL
CONTROL DATA SPECIFICATION FOR
THE MOD-5A WIND TURBINE GENERATOR
JULY 1983

Michael L. LeBorgne
Responsible Engineer

DATE: 7-18-83

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DATE: 7-20-83

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DATE: 7-19-83

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DIV OR
DEPT.

47A380116

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A. E. P. 7/21/83

KING OF PRUSSIA, PA.

LOCATION

CONT ON SHEET *ii*

SH NO. *i*

REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

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SECTION 1

1.0 SCOPE

This specification defines the forging material, heat treatment, material finish and inspection requirements (material and finished part) for the MOD-5A WTG PSC Spindle (47E382299) or as specified.

SECTION 2

2.0 MATERIAL

2.1 FORGING

ASTM A723 Grade 1, Class 1 (including S3) degassed and electro slag remelted (ESR) with material normalized at 1700°F for four (4) hours, air cooled and tempered four (4) hours at 1200°F.

- A) Forging shall include stock at both ends for test specimens per ASTM A723, Paragraph 6.2.1 method 1 and Paragraph 6.6.3.
- B) Micro-cleanliness (TBD)
- C) Hardenability shall be J50=6 and J47=20 per ASTM A255
- D) Grain direction shall be as shown on drawing.

2.2 HEAT TREATMENT

After rough machining austenize at 1525°F for two (2) hours and oil quench followed by tempering at 1200°F for six (6) hours. Hardness to be R_C 25 to 28 at 1/4 thickness and Charpy V Notch (CVN) toughness to be greater than 30 ft-lb at -40°F per supplemental requirement S3 (ASTM 723). Grain size to be ASTM #5 or finer.

2.3 DOCUMENTATION

Written report including material certification (physical and chemical), furnace tapes, hardness reading, CVN and dimensional data to be supplied.

SECTION 3

3.0 INSPECTION

3.1 ULTRASONIC

Forging shall be 100% straight beam ultrasonically inspected per ASTM A-388. Finished part prior to shot peening and plating shall be 100% straight and angle beam inspected per ASTM A-388. Any indications greater than that produced by the criteria stated in Table 3-1 shall be cause for rejection. Zones A or B (Table 3-1) are to be applied as stated on applicable drawing.

Indications which have a signal amplitude of 50% of reference signal amplitude are relevant. Relevant indications must be separated by at least three times the rejection criteria. No more than ten (10) relevant indications are permitted in any six (6) square inch area with major dimension not to exceed six (6) inches. No more than four (4) relevant indications are permitted in any one (1) square inch area with major dimension not to exceed one (1) inch. Non conformance with above requirement shall be cause for rejection.

3.2 MAGNETIC PARTICLE

Finished part (prior to shot peening and plating) to be 100% magnetic particle inspected on O.D. per ASTM A-275. Any indications greater than that produced by the criteria stated in Table 3-1 shall be cause for rejection. Zones A or B (Table 3-1) are to be applied as stated on applicable drawing. Indications one half the rejection criteria or greater are relevant. Relevant indication must be separated by at least three times the rejection criteria. No more than ten (10) relevant indications are permitted in any six (6) square inch area with major dimension not to exceed six (6) inches. No more than four (4) relevant indications are permitted in any one (1) square inch area with major dimension not to exceed one (1) inch. Non conformance with above requirement shall be cause for rejection.

TABLE 3-1
INSPECTION CRITERIA
(Inches)

	<u>Ultrasonic Criteria</u>		<u>Magnetic Particle Criteria</u>
	<u>Flat Bottom Hole Size</u>	<u>60° V- Notch Size</u>	
Zone A	.060	.060	.040
Zone B	.100	.100	.080

3.3 DOCUMENTATION

Written report of all inspection procedures, and findings to be supplied by vendor.

SECTION 4

4.0 FINISH

4.1 CHROME AND NICKEL PLATING

As required on the drawing. Dimensions apply after finish.

4.1.1 SHOT PEEN

Shot peen per MIL-S-13165 using 110 steel shot prior to plating. Manually controlled equipment shall not be used. Optional to peen entire external surface. Arc height to be .008 - .012 inch, Almen 2 intensity, coverage 200%.

4.1.2 PLATING

Plate, after shot peening, the indicated surfaces as follows: underplate with nickel per QQ-N-290 Type II minimum thickness .002 inch. Overplate with chrome per QQ-C-320, Class IIA, minimum thickness .001 inch maximum thickness of combined nickel and chrome .006 inch.

4.1.3 HYDROGEN BAKE OUT

Within four (4) hours after plating, shaft shall be baked at $375^{\circ} \pm 25^{\circ}\text{F}$ for eight (8) hours.

4.2 FINISH PAINT

After final machining, clean, prime and top coat per GE Specification 47A380048 (Exterior Sea Coast Environment). See drawing for painted surfaces.

4.3 UNPAINTED SURFACES

Apply a (TBD) temporary protective coating to unpainted surfaces. See drawing for location.

47A380118

REV NO.	TITLE	CONT ON SHEET	SH NO.
47A380118		ii	i
FIRST MADE FOR			

SPECIFICATION FOR THE YAW DRIVE
HYDRAULIC CONTROL UNIT
AUGUST 1983

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Responsible Engineer

DATE: 8/22/83

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DATE: 8/22/83

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DATE: 8/22/83

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DATE: 8-22-83

J. F. [Signature]
Manufacturing

DATE: 8/23/83

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ISSUED <u>8/24/83</u>	<u>KING OF PRUSSIA, PA</u>	LOCATION	CONT ON SHEET <u>i</u> SH NO. <u>ii</u>

REVISION LOG

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SECTION 1.0 INTRODUCTION

1.1 SCOPE

The objective of this specification is to describe the characteristics of a hydraulic control unit for the Yaw Drive System of the MOD-5A Wind Turbine Generator. The vendor will work with GE to arrive at a design that will meet the technical requirements described in this document.

SECTION 2.0
APPLICABLE DOCUMENTS

2.1 GENERAL ELECTRIC DRAWINGS

47E382314 Yaw Drive Hydraulic Schematic

2.2 SPECIFICATIONS

MIL-H-5606ATF Hydraulic Fluid

SECTION 3.0 REQUIREMENTS

3.1 GENERAL

This requirement of this unit is to provide hydraulic power storage capability and also provide for the control of hydraulic power to the yaw drive assembly. This unit functions in conjunction with the yaw drive hydraulic power supply.

3.2 CONFIGURATION

Figure 1 depicts the suggested equipment layout and overall configuration. This subassembly is mounted directly to the upper yaw structure. The maximum overall dimensions and interface areas are depicted in Figure 1.

3.3 WEIGHT

The weight goal of the subassembly including components, structure, piping, fittings, and fluid is 1800 lb.

3.4 PERFORMANCE AND OPERATING CRITERIA

3.4.1 ENVIRONMENT

The hydraulic control unit shall be designed to withstand conditions encountered when housed in an unsealed protected enclosure. The subassembly will be located in a range of atmospheric environments experienced from New England to Alaska or the Caribbean area to hot desert climates. Non-operating temperature extremes of -40 F to +140 F will be experienced. The operable temperature range is -22 F to 110 F. Outdoor conditions of rain, hail, sleet, snow, salt spray, etc. will be encountered during storage and installation.

Corrosion protection is of primary importance since the environment can include salt spray and/or sand and dust. Equipment should be capable of withstanding an air salt loading of .05 PPM. Any recommended maintenance, in order to assure the unit will provide the life requirement specified in Section 2.5, shall be specified by the supplier.

3.4.2 ENVELOPE

Figure 1 illustrates the maximum envelope dimensions (60" x 45" x 15").

3.4.3 OUTPUT

The unit shall be capable of providing a constant output of 5 gal/min at pressures up to 3000 psi. See GE schematic 47E382314 for additional details. As shown on the schematic, three (3) "no flow" circuits must also provide pressure up to 3000 psi.

3.4.4 POWER SOURCE AND CONTROL

A 120 V, 60 Hz electrical supply will be provided for solenoid valves and pressure switches. The solenoid valves shall require less than 4.2 Amp inrush current and .85 Amp holding current. The pressure switch contacts shall be capable of 20 ma at 120V, 60 Hz.

3.4.5 DUTY CYCLE

The expected duty cycle for this system is given below. A major portion of the operating time is at low pressures, or off.

<u>% Time Of Operation</u>	<u>Normal Operating Supply</u>
15%	5 gpm, 2000 psi
15%	6 gpm, 3000 psi
70%	off

3.4.6 FLUID/ACCUMULATORS

The hydraulic fluid shall be MIL-H-5606 ATF, Dexron II, Mobil fluid 300 or Shell Donax T6.

All accumulators shall be bladder type and in addition have a design pressure rating of 3000 psi minimum.

3.4.7 SYSTEM PRESSURE LEVELS

Unless otherwise specified all components, fittings, sensing devices, and interconnecting piping shall be designed to operate with an internal pressure of 3000 psig. Exceptions are drain and suction lines. All components shall be capable of withstanding a proof pressure test of 1.5 times the nominal pressure level without degradation of performance. The system and all components shall be capable of surviving an internal vacuum pressure of 10 mm Hg. absolute.

3.4.8 LEAKAGE

There shall be no evidence of external leakage, under normal visual inspection and wipe testing, when the system is pressurized to normal operating pressure levels. All valves shall exhibit a maximum internal leakage of 1 drop per minute.

3.4.9 MATERIAL COMPATIBILITY

All materials of construction shall be compatible with the hydraulic fluid specified in Section 3.4.6.

3.4.10 LINE SIZES AND MATERIALS

All interconnecting tubing shall be sized for velocities of 15 fps minimum and 30 fps maximum in accordance with accepted design practice. Material shall be ASTM A-269, type 304, 316, or other approved grades.

3.4.11 DRAINING AND VENTING

Provision shall be made for bleeding, draining and venting all circuits of the hydraulic power supply.

3.4.12 TUBING ASSEMBLIES AND FITTINGS

Tube connections and interfaces shall be welded wherever possible. Wherever welded tubing assemblies are not practical due to component availability or maintenance, Lenz O-ring fittings or equivalent shall be used.

3.4.13 PROTECTIVE COATING

All components of the hydraulic power supply exposed to the environment described in Section 3.4.1 shall be finished per GE Specification 47A380048, semi gloss white, per Federal Standard 27875.

3.4.14 STRUCTURAL SUPPORT AND INTERFACE

The hydraulic power supply will be mechanically attached to the upper yaw structure as depicted in Figure 1. Size and location of fasteners to be as shown in Figure 1. The hydraulic component support structure shall be designed to support the components defined by this specification.

3.4.15 ELECTRICAL INTERFACES

All wiring shall terminate at an enclosed terminal strip with wire clamps capable of accepting up to AWG No. 12 size wire.

3.5 GENERAL DESIGN REQUIREMENT

3.5.1 AVAILABILITY

The Hydraulic Control Unit shall be designed for a minimum availability of 99.7% over the service life, with a minimum MTBF of 4000 hrs. Special consideration shall be given to servicing and maintenance of critical areas.

3.5.2 PARTS AND COMPONENTS

The system shall utilize state-of-the-art components with a proven record of experience.

3.5.3 MAINTENANCE AND SERVICEABILITY

The system shall provide for safe and easy maintenance wherever possible, including removable covers or shrouds. All parts and components shall be designed for easy handling and lifting.

3.5.4 TRANSPORTABILITY AND HANDLING

When designing the system, consideration should be given to transportation via existing surface vehicles and handling or lifting by means of a fork lift truck. Lifting lugs or eye bolts shall be provided to facilitate lifting and handling. Lifting provisions shall be designed with a strength safety factor of six (6).

3.5.5 REVIEW AND APPROVAL

Prior to fabrication, the supplier shall submit the detailed design for GE approval that it meets the requirements of this specification.

3.6 DEVIATIONS FROM SPECIFICATION

All deviations from specification and drawings shall be approved by General Electric prior to installation of hardware.

3.7 LIFE

Due to the criticality of this component the design must be extremely reliable. The WTG is being designed for a useful life of 30 years. The supplier shall provide the necessary maintenance instructions and/or component replacement schedule to attain the aforementioned 30 year requirement.

SECTION 4.0

QUALITY ASSURANCE PROVISIONS

The Hydraulic Control Unit supplier shall provide a brief description of his Quality Control/Inspection System, showing how he controls:

- a) Measuring and Test Equipment
- b) Processes
- c) Materials
- d) Non-conforming Material

4.1 ACCEPTANCE TESTING

The supplier shall provide a brief description of his in-house acceptance tests prior to delivery to the General Electric Company. Two General Electric representatives shall be permitted to witness any or all tests at the vendor's plant. GE Procurement shall be notified forty-eight (48) hours in advance of testing.

4.2 REPORTS

The vendor shall supply three (3) copies of all quality control reports and test results.

4.3 MINIMUM TEST PROGRAM

As a minimum the supplier shall conduct the following tests:

- a) Proof Pressure Test - Pressurize each circuit to 1.5 times its nominal working pressure. No performance degradation shall occur following this test.

4.3 MINIMUM TEST PROGRAM (cont'd)

- b) External Leakage - "Wipe test" and visually observe all fittings, components and tubing joints for external leaks, with each element pressurized to nominal working pressure. No visible evidence of leakage shall occur for 2 hours.
- c) Functionally test each component under nominal operating conditions. Each power supply shall be run with the outlet dead-ended and the resulting outlet pressure measured. Flow capacity of each supply shall be measured by means of flow meters - flow rate shall meet specified requirement.

SECTION 5.0
PREPARATION FOR DELIVERY

5.1 SHIPPING CONTAINERS

The shipping containers and method of shipment shall be approved by the General Electric Company prior to shipment of the Hydraulic Control Unit. All interface connections shall be capped or plugged to prevent entry of contaminants. After testing per 4.0, the system shall be drained and thoroughly cleaned, all strainers and filter elements shall be replaced and the unit shall be filled with Dexron II.

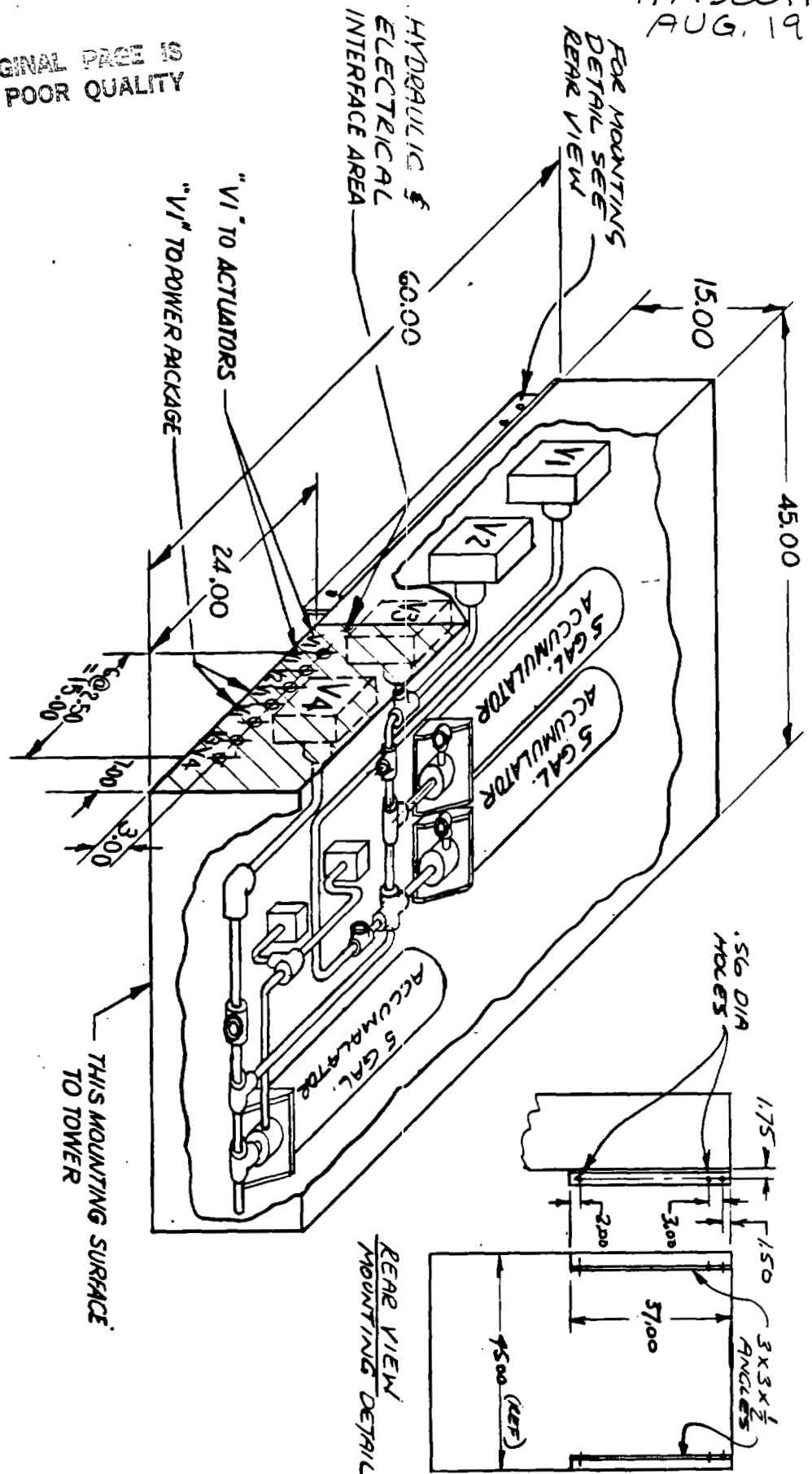
5.2 DOCUMENTATION

The vendor shall supply a Parts List, Service and Maintenance Manuals, Operating Instructions, Reproducible Drawings, List of Recommended Spares and Troubleshooting Instructions for the hydraulic control unit and its component parts. The vendor shall also supply procedures for shutdown, long storage period, and startup inspections.

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OF POOR QUALITY

FIG 1 YAW HYDRAULIC CONTROL UNIT

NOTE: ALL TUBE INTERFACES TO BE
SAE STD STRAIGHT THREAD O-RING SEAL BOSS
FOR 1/2" OD TUBING



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TITLE

CONT ON SHEET *ii*SH NO. *i*

47A380121

CONT ON SHEET *ii*SH NO. *i*

FIRST MADE FOR

REVISION

SPECIFICATION FOR
ALLOY STEEL TWELVE (12) POINT HEAD BOLT
140,000 PSI ULTIMATE STRENGTH
SEPTEMBER 1983

Rag Riddin
Responsible Engineer

DATE: *Oct 8/83.*

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Materials Engineer

DATE: *Oct. 10/83*

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DATE: _____

TOTAL No. PAGES *25*

WTG

500

PRINTS TO

MADE BY

APPROVALS

ISSUED

A. E. P. *11/10/83**A. E. P.*

DEPT.

47A380121

KING OF PRUSSIA, PA.

LOCATION

CONT ON SHEET *ii*SH NO. *i*

CODE IDENT NO.

REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping.

Revision	Page No.	Paragraph Number(s) Affected	Rev. Date	Approval
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SECTION 1

1.0 SCOPE

This specification identifies an alloy steel, heat-treated, upset roll-threaded bolt, the conditions of which are identified on:

47C381036 - Finish and dimensions per drawing, 140,000 PSI tensile

This specification is similar to GE Transportation Systems Business Division (TSBD) Specification C50E46.

SECTION 2 - APPLICABLE DOCUMENTS

GE Drawings	-	47C381036
GE Specifications	-	C50E46
Military Specifications	-	MIL-H-6815
Military Standards	-	MIL-STD-1312
		AMS 6322
		AMS 6415

SECTION 3 - DESIGN AND FABRICATION

3.1 MATERIAL

Bolts to this specification shall be made from an alloy steel, aircraft quality, either AMS 6322 (AISI 8740) or AMS 6415 (AISI 4340) suitable for heat-treatment to the specified mechanical properties.

3.2.1 Blanks

Heads shall be formed by hot or cold upsetting. The metal removed from the bearing surface of the head of upset-head parts shall be as little as practicable to obtain a clean, smooth surface.

3.2.2 Hardenability

The material and process shall produce a minimum hardness of 47 Rockwell "C" at the center of the threaded end, one diameter from the end of the bolt after oil quenching and prior to tempering.

3.2.3 Machining Sequence

Headed and machined blanks shall be quenched and tempered prior to finish machining. A minimum of 000.005" stock shall be left on all cylindrical surfaces, washer face, and radius between washer face and shank, prior to heat treatment. The bolt head, excluding the washer face and top may be to drawing size prior to quenching and tempering. The threads shall be rolled after heat treatment.

3.2.4 Heat Treatment

Bolts shall be heat-treated in accordance with Specification MIL-H-6875 to develop the mechanical properties specified herein. All bolts shall be

3.2.4 Heat Treatment (continued)

retempered subsequent to grinding and prior to thread rolling and fillet working (if specified on drawing) at a temperature from 0°F below the original tempering temperature to a maximum of 50°F below the original tempering temperature.

3.2.5 Thread Rolling

Threads shall be formed on the heat treated and finished blanks by a single rolling.

3.2.6 Fillet Working

The head to shank fillet shall be cold worked. Permissible distortion shall be as shown in Figure 13.

3.3 Flow Lines

Flow lines of upset heads shall conform to the general arrangement shown in Figure 1. The intersection of the longitudinal axis of the part and the approximate transverse axis of the flow lines shall be not less than $D/7$ in. from the bearing surface of the head where D is the nominal diameter of the shank after heading.

3.4 Examination for Internal Defects

Visual examination of a longitudinal section of a head and 1/4" or more of the shank, after etching in approximately equal volumes of hydrochloric acid (sp. gr. 1.19) and water at 160°-180°F for 10-12 minutes shall reveal no cracks, laps, or porosity.

3.5 Threads

3.5.1 Flow lines at threads shall be continuous, shall follow the general thread contour, and shall be of maximum density at the root of the thread (See Fig. 2).

3.5.2 Root defects such as notches, slivers, folds, roughness, or oxide scale are not permitted (See Fig. 3).

3.5.3 Multiple laps on the sides of the threads are not permissible regardless of location. Single laps on the sides of threads that extend toward the root are not permissible (See Figs. 4 and 5).

3.5.4 A single lap is permissible along the side of the thread below the pitch diameter on the nonpressure side provided the lap does not originate closer than 20% of the basic thread height from the root and extends toward the crest and generally parallel to the side (See Fig. 6). A single lap is permissible along the side of the thread above the pitch diameter on either the pressure or nonpressure side (one lap per thread) provided it extends toward the crest and is generally parallel to the side (See Fig. 7). Basic thread height is defined as being equivalent to 0.650 times the pitch (See Table VI).

3.5.5 Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible, provided that the imperfection does not extend deeper than 25% of the basic thread height (See Table VI) as measured from the thread crest when the thread major diameter is at minimum size (See Fig. 8). As the major diameter of the thread approaches maximum size, values for crest crater or

3.5.5 (continued)

crest lap imperfections listed in Table VI may be increased by 1/2 the difference between the minimum major diameter and the actual major diameter as measured on the part.

3.5.6 Slight deviations from thread contour are permissible at the crest of the thread within the major diameter limits as shown in Figure 9 and at the incomplete thread at each end of the threaded section.

3.5.7 Parts shall have a maximum thread runout of two threads. The runout shall fair onto the shank eliminating any abrupt change in cross-sectional area. Bottom and sides of threads contained in the runout shall be filleted, smooth, and devoid of abrupt tool stop marks. See detail on GE drawing 47C381036.

3.5.8 All thread elements shall be within specified limits starting at a length two times the pitch from the end, including chamfer, and extending for the specified full thread length. On plated parts, threads may be 0.001" under the specified limits before plating, but shall conform to the gage requirements after plating.

3.6 Straightness, Concentricity, and Squareness

For purposes of these inspections, shank and threads shall be considered as separate elements of the bolt.

3.6.1 Straightness of Shank and Threads

Shank and threads shall be straight within the limits specified on the drawing for the total length (L) of the bolt under the head (See Figure 10). Visibly

abrupt changes in diameter or shape of the shank and threads which might cause stress concentrations are not permissible, except that the rolled thread may have a natural blend of metal formed or displaced during thread rolling.

3.6.2 Concentricity of Thread Pitch Diameter

The concentricity of thread pitch diameter in relation to shank diameter shall be within the limits specified on the drawing for a distance of not less than 1.5 times the nominal bolt diameter (see Figure 11). For bolts having a shank length less than 1.5 times the nominal bolt diameter, the concentricity of the shank diameter over its full length in relation to the thread pitch diameter shall be within the limits specified on the drawing.

3.6.3 Concentricity of Head

The concentricity of the head in relation to the shank diameter shall be within the limits specified on the drawing for a distance of not less than 1.5 times the nominal bolt diameter away from the washer face along the shank (See Figure 12). For bolts threaded to the head and for bolts having shank length less than 1.5 times the nominal bolt diameter, concentricity of head shall be measured in relation to thread pitch diameter in lieu of shank diameter.

3.6.4 Squareness of Washer Face

The squareness of the bearing surface with the shank diameter shall be within the limits specified on the drawing for a distance of not less than 1.5 times the nominal bolt diameter away from the bearing surface along the shank (See Figure 12). For bolts threaded to the head and for bolts having a shank length less than 1.5 times the nominal bolt diameter, squareness of the bearing surface shall be measured in relation to thread pitch diameter in lieu of shank diameter.

3.7 Structure

Parts shall have microstructure of tempered martensite.

3.8 Hardness

Hardness of quenched and tempered bolts shall be uniform and within the range specified in Section 3.11 of this specification, but hardness of the threaded portion may be higher as a result of thread rolling.

3.9 Surface Hardening

Parts shall have no surface hardening except as produced during rolling of threads or during working of head to shank fillets. Determinations of surface hardening may be made by microscope or by a sensitive hardness testing instrument.

3.10 Decarburization

The bearing surface of the head, the fillet between head and shank, the shank, and threads shall be free from decarburization. Where the drawing permits "as forged" surfaces, or surfaces not machined or ground subsequent to previous metal forming operations, depth of decarburization on such noncritical surfaces is not restricted.

Depth of decarburization at any point on the surface not covered by other requirements of this specification shall not exceed 0.002".

3.11 Mechanical Properties

3.11.1 Tensile and Hardness Properties

Tensile test specimens machined from heat treated bolts shall meet the following

3.11.1 Tensile and Hardness Properties (continued)

minimum mechanical properties:

Tensile Strength, PSI	140,000 Min.
Yield Strength (0.02% offset), PSI	120,000 Min.
Elongation in 2", %	15 Min.
Reduction of Area, %	40 Min.
Hardness, Rc	30 - 36
Hardness, BHN	240-275

In addition, full sized bolts shall be used as test specimens and shall meet the minimum ultimate tensile loading in pounds as shown in Table I (See also Section 4.5).

TABLE I
ULTIMATE TENSILE LOAD - POUNDS MINIMUM

DIAMETER	THREADS/IN.	TENSILE LOAD LBS MIN	PROOF LOAD LBS MIN
1	12 UNF	92,800	74,200
1 1/4	12 UNF	150,000	120,000
1 1/2	12 UNF	221,000	176,800
1 3/4	8 UN	292,000	233,800
2	8 UN	388,000	310,400
2 1/4	8 UN	498,000	398,400

The listed ultimate tensile load values are based on the stress area at the basic pitch diameter and 140 KSI.

Sampling: (for tensile testing only)

TABLE II
(Sampling Plan for Tensile Tests)

<u>Lot*</u> <u>Size</u>	<u>Sample</u> <u>Size</u>	<u>Acceptance</u> <u>Number</u>	<u>Rejection</u> <u>Number</u>
25 or less	2	0	1
26 - 150	3	0	1
151 - 200	5	0	1

*Manufacturing lot size may be larger or smaller than a purchase order or shipment lot size.

3.11.2 Fatigue Strength

Finished bolts shall meet the acceptance criteria defined in this section. Tests are not required for bolts having a nominal grip less than three times the nominal diameter. Fatigue tests may be discontinued after 130,000 cycles if bolt fatigue has not occurred.

Sampling - Samples shall be selected in accordance with Table III.

TABLE III

ATTRIBUTE SAMPLING PLAN FOR FATIGUE TESTS

<u>Lot Size</u>	<u>Sample No.</u>	<u>Sample Size</u>	<u>Total</u>
Under 301	First	3	3
	Second	2	5
	Third	5	10
301 - 500	First	4	4
	Second	3	7
	Third	7	14
501 - 1300	First	5	5
	Second	4	9
	Third	9	18

Tests: The fatigue loading applied to the bolts shall be tension-tension in accordance with MIL-STD-1312, Test No. 11. The tests shall be conducted at room temperature. The fatigue loadings applied to the respective bolts shall conform to Table IV.

Evaluation of Tests: Evaluate each sample number for fatigue as follows: When calculating the average fatigue life, use the figures representing the number of cycles at the time of bolt failure, number of cycles when test was discontinued or number 130,000, whichever is less.

Acceptance Criteria:

First Sample: Accept if the life of each fastener exceeds 100,000 cycles. reject entire lot if average life is less than 65,000 cycles or if one or more individual fastener fails in less than 45,000 cycles. Take second sample if

3.11.2 Fatigue Strength (continued)

lot is not accepted or rejected on first sample.

Second Sample: Accept if the average life in the first and second sample exceeds 80,000 cycles and no individual sample is less than 45,000 cycles. Reject entire lot if the combined first and second sample has an average life of less than 65,000 cycles or if one or more individual fastener fails in less than 45,000 cycles. Take third sample if lot is not accepted or rejected on combined first and second sample.

Third Sample: Accept if the average life in the three combined samples exceeds 65,000 cycles and no individual sample is less than 45,000 cycles. Reject entire lot if not accepted under the preceding requirement.

TABLE IV
FATIGUE LOADING - POUNDS
FINE THREAD - FILLET COLD WORKED

NOMINAL DIAMETER	AREA	HIGH (a)	LOW (b)
1.000-12	.6630	47,700	4,770
1.125-12	.856	60,200	6,020
1.250-12	1.073	75,700	7,570
1.375-12	1.314	90,800	9,080
1.500-12	1.581	110,000	11,000
1.750-8	2.082	125,000	12,500
2.000-8	2.771	140,000	14,000
2.250-8	3.557	178,000	17,800

Note:

- (a) High Tension fatigue loading at room temperature is based on *calculated at the basic pitch diameter area.

(b) Low tension fatigue load at room temperature is 10% of high tension fatigue load shown in (a).

*51% of the minimum ultimate tensile strength (72,000 psi).

3.11.3 Wrenching Strength of 12 Point Head Configuration:

The twelve point head shall be of sufficient strength that, when the bolt is torqued to failure, fracture shall occur in the thread or shank area.

3.12 Finish

Coat entire surface of bolts (nuts and washers when called for) with Stand-Cote SC-1 ceramic-filled, baked-on PTFE Fluorocarbon Resin Coating, per manufacturer recommended practices.

Recommended Manufacturer - Standco Industries Inc., Bolt and Nut Division, Houston, Texas.

SECTION 4 - QUALITY ASSURANCE PROVISIONS

4.1 Cleaning

Parts shall be uniform in quality and condition, clean, sound, smooth and free from burrs and foreign materials and from internal and external imperfections detrimental to their performance.

4.2 Magnetic Particle Inspection

Parts are subject to magnetic particle inspection and shall conform to the following standards, unless otherwise specified on the drawing:

Discontinuities transverse to grain flow such as pipes, grinding checks, and quench cracks shall be cause for rejection. Longitudinal indications of seams, forming laps and nonmetallic inclusions parallel to grain flow are acceptable within limits shown in Table V, provided the separation between indications is not less than 1/16" in all directions, and that no indication shall break into a fillet or over an edge.

Vendor to certify that all parts supplied have satisfactorily completed the magnetic particle inspection.

TABLE V

Location (no more than 6 indications permitted in any one location).	Discontinuity	0.250 & 0.312	0.375	0.438	0.500 & Greater
		Maximum Depth			
Head to shank fillet	None	0.000	0.000	0.000	0.000
Shank and bearing surface of head.	Seams not extending into fillet or over an edge.	0.005	0.006	0.007	0.008
Non-bearing surface of head.	Laps, seams, nicks or gouges.	0.010	0.012	0.014	0.016
Any other location.	Inclusions not indicative of unsatisfactory quality.				

4.3 Threads

Threads shall not reveal indications of cracks, seams, pipes or rolling laps as shown by Figures 3, 4 and 5 except that indications of slight laps as shown by Figures 6, 7 and 8 will be permitted.

4.4 Rockwell Hardness and Tensile Tests - ASTM A-370

All Rockwell hardness readings shall be taken on the thread end. Except as permitted in Sections 3.11.1 and 4.5, tensile tests specimens shall consist of actual finished bolts. If the percent elongation of any test specimen is less than that specified, and any part of the fracture is more than $3/8$ of the gage length from the middle of the gage length, as indicated by scribe lines marked on the specimen before testing, a retest shall be made.

4.5 Specimen

Where bolts cannot be tested in full size for tensile strength requirements, machined specimens shall be used. The bolts shall have their shanks machined to the dimensions of a standard 0.505 in. test specimen concentric with the axis of the bolt leaving the head and threaded section of the bolt intact. (see Section 3.11.1).

4.6 Certification of Test

The supplier must submit to the Manager - Quality Control, Advanced Energy Programs Department, a certificate showing the results of tests to determine conformance to the technical requirements of this specification. Any deviations from the specification must have prior approval of General Electric prior to shipment. If parts are serialized, conformance data must be referenced to serial numbers, to afford positive identification with individual parts.

4.7 Rejections

Parts not conforming to this specification or to authorized modifications will be subject to rejection.

TABLE VI

AMERICAN NATIONAL & UNIFIED THREADS

THREADS PER INCH	BASIC THREAD HEIGHT REFERENCE	25% BASIC THREAD HEIGHT
8 UN	0.0767	0.0191
12 UNF	0.0511	0.0128

SECTION 5 - PREPARATION FOR SHIPMENT

5.1 PACKING AND MARKING

The bolts shall be individually identified by permanently marking the face in accordance with drawing instructions. All containers shall be marked with the General Electric purchase order, manufacturer's name, and General Electric material designation, and drawing No. 47C381036P-per drawing instructions.

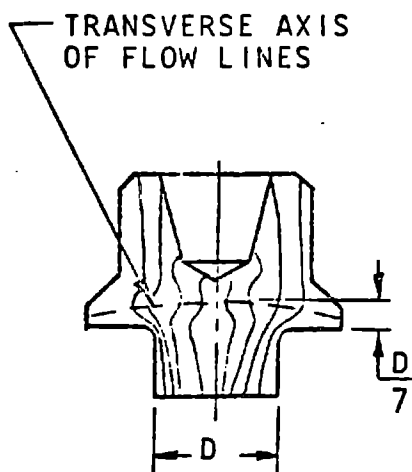


FIGURE 1

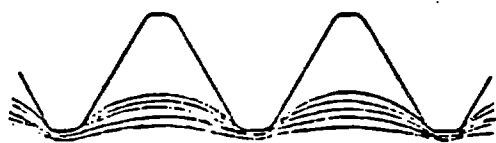


FIGURE 2
FLOW LINES

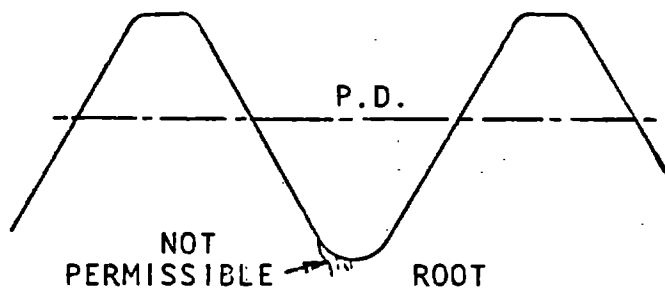


FIGURE 3

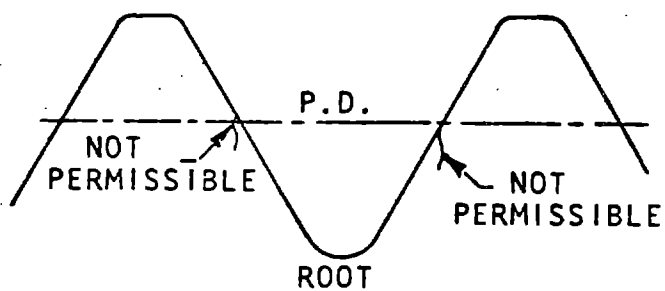


FIGURE 4

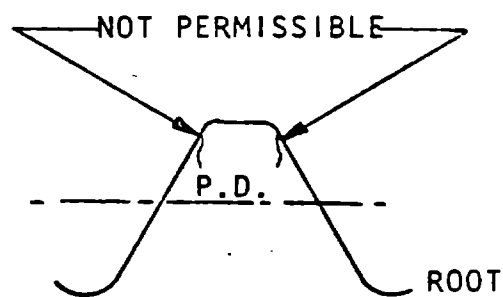


FIGURE 5

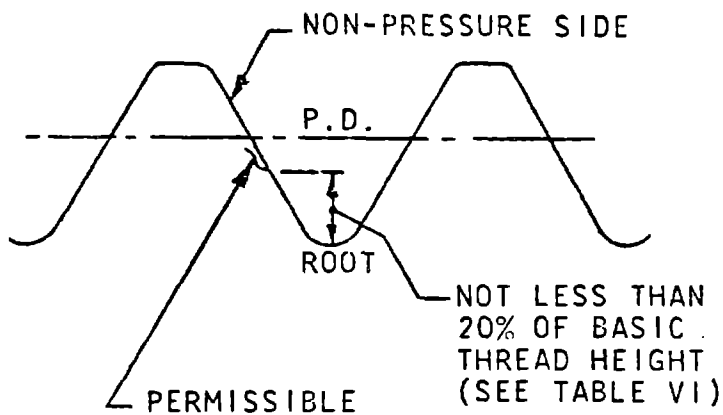


FIGURE 6

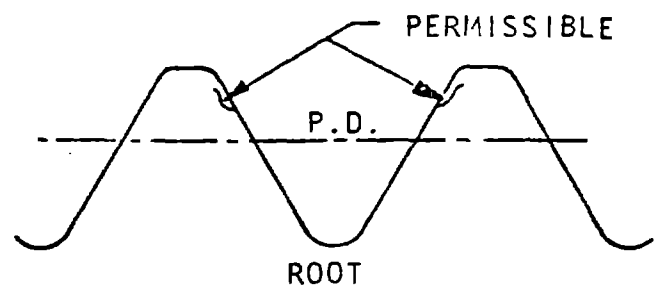
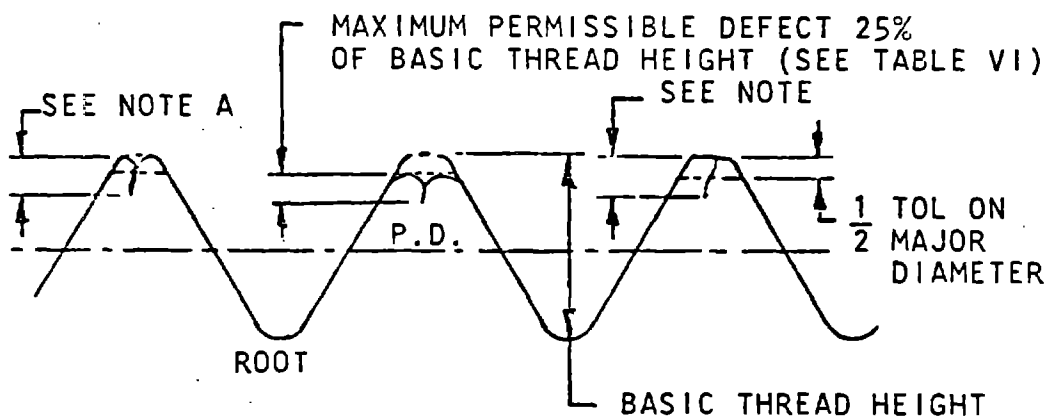


FIGURE 7



NOTE A: DEPTH OF DEFECT EQUALS 25% OF BASIC THREAD HEIGHT PLUS $\frac{1}{2}$ THE DIFFERENCE BETWEEN THE ACTUAL MAJOR DIAMETER AND MINIMUM MAJOR DIAMETER.

FIGURE 8

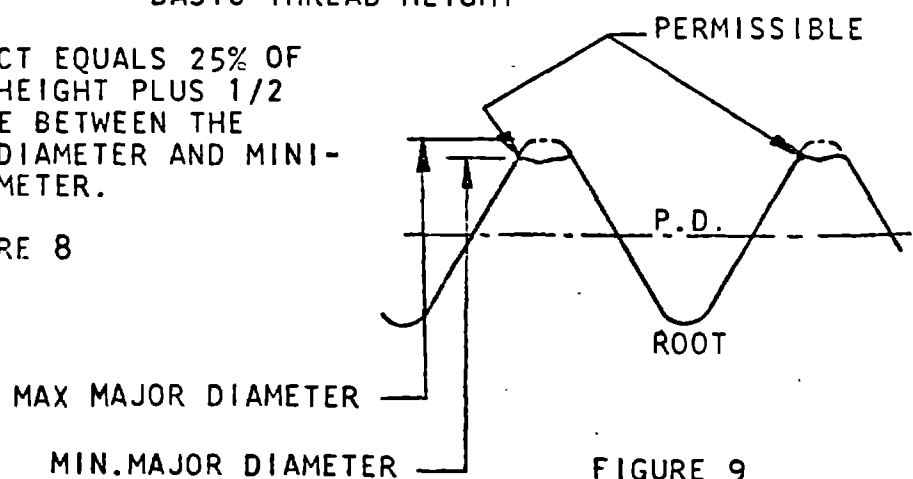


FIGURE 9

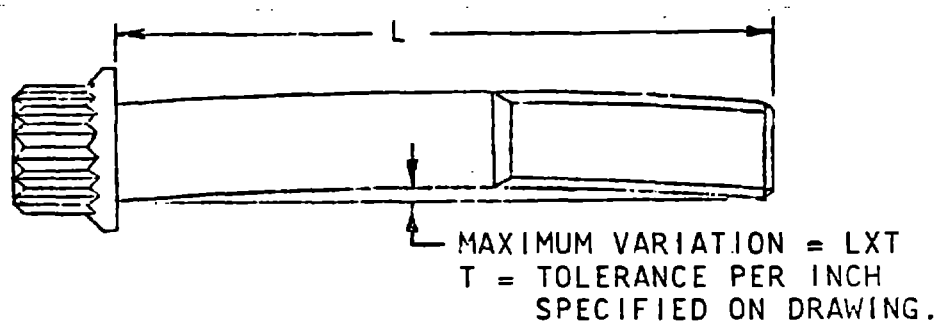


FIGURE 10

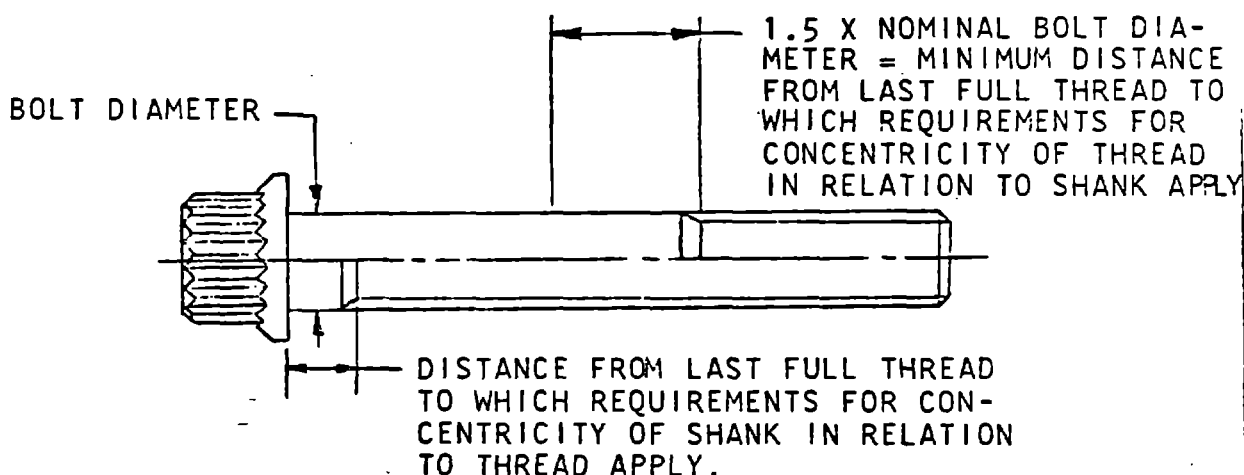


FIGURE 11

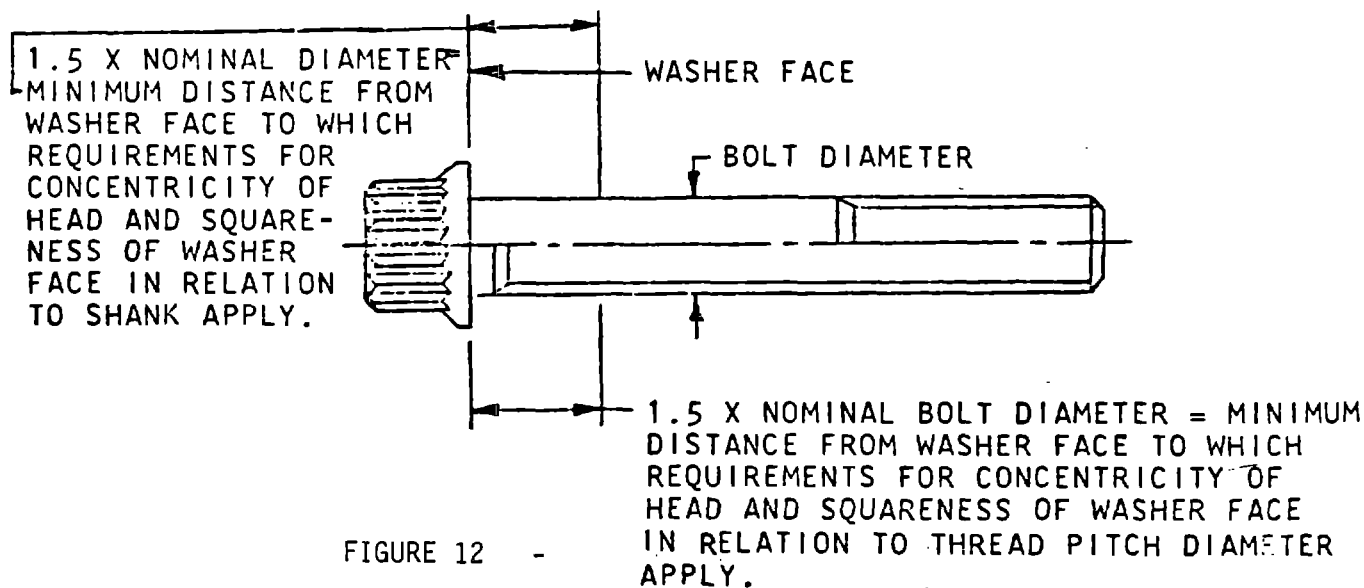
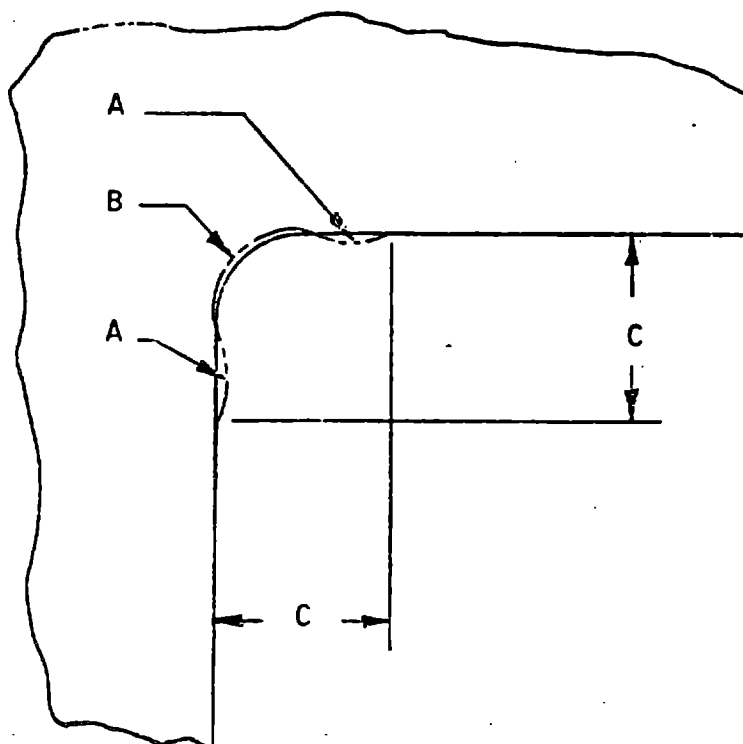


FIGURE 12



MAXIMUM DISTRIBUTION	NOMINAL SIZE	
	1.000	OVER 1.000
C	.156	.188

Cold working of head to shank fillet may cause distortion of fillet area. Distortion shall not exceed .002 above (A) or below (B) contour shown on bolt drawing. Distorted area shall not extend beyond (C) as illustrated.

FIGURE 13

ALLOWABLE FILLET DISTORTION

(WHEN COLD WORK FILLETS ARE SPECIFIED ON THE DRAWINGS.) Distortion shall not exceed .002 above (A) or below (B) contour shown on bolt drawing. Distorted area shall not extend beyond (C) as illustrated.

FIGURE 13

47A380124

REV NO.	TITLE	CONT ON SHEET <i>ii</i>	SH NO. <i>i</i>
47A380124	FIRST MADE FOR		

SPECIFICATION
FOR
MOD-5A WTG
AILERON STRUCTURES

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	KING OF PRUSSIA, PA. LOCATION	CONT ON SHEET <i>ii</i>	SH NO. <i>i</i>

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REVISION LOG

This log identifies those portions of this document which have been revised since original issue. Revised portions of each page, for the current revision only, are identified by marginal striping or text notes.

<u>Revision</u>	<u>Page No.</u>	<u>Paragraph Number (s) Affected</u>	<u>Rev. Date Approval</u>
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SECTION 1.0

SCOPE

This specification establishes the performance, design, manufacture, test and acceptance requirements for the aerodynamic control surfaces, ailerons, for the MOD-5A Wind Turbine Generator (WTG) Rotor.

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SECTION 2.0
APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. The issue in effect on date of invitation for bids shall apply unless otherwise noted.

2.1 DRAWINGS, GENERAL ELECTRIC

TBD Aileron Structural Interfaces - MOD-5A WTG
TBD Aileron Hydraulic Interfaces - MOD-5A WTG
TBD Aileron Electrical Interfaces - MOD-5A WTG
TBD Aileron Space Allocation - MOD-5A WTG

2.2 SPECIFICATIONS, GENERAL ELECTRIC

47A382285 Aerodynamic Profile Coordinates - Rotor Blade MOD-5A WTG
(Latest Revision)
47A380002 Aileron Actuator
47A380048 Material Finishes, MOD-5A Structure

2.3 OTHER

MIL-HDBK-5C Military Handbook, Metallic Materials and Elements for
Aerospace Vehicle Structure.

MIL-HDBK-17 Military Handbook, Plastics for Flight Vehicles

MIL-HDBK-23 Military Handbook, Structural Sandwich composites

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SECTION 3.0 REQUIREMENTS

3.1 General

3.1.1 Item Description

The aileron control surfaces for the MOD-5A WTG are shown in Figure 3.1.1. The ailerons consist of 6 sections per blade (2 blades per WTG) extending from 60% (station 1440) of blade span to 99% (station 2376) and from 60% of blade chord to the trailing edge. These sections are driven in pairs by a linear hydraulic actuator through -90° of rotation about a hinge axis 2.75 inches toward the trailing edge from the local 60% chord line. The actuator drives the inboard aileron structure (of the pair) with the outboard driven via a torque link between the two structures. The aileron structures pivot on spherical self-aligning bearings at each end with thrust bearings at the common hinge point between each pair of aileron structures to react the centrifugal induced axial loads.

3.1.2 Interface Definition

3.1.2.1 Structural Interface

The aileron structure shall interface with the blade structure at the 60% spar. The actuator, provided by GE, shall interface with the aileron and hinge via shear pins defined in structural interface drawing #TBD. The aileron structure shall provide clearance of approximately six inches between its forward spar and the aft surface of the blade's 60% of chord spar to permit routing of hydraulic and electrical conduit lines. A sealing surface or interface between the aileron leading edge and the 60% chord of the blade shall be provided. The aileron subcontractor shall supply hinge fittings to be mated to the 60% spar. The WTG blade is a NACA 64XXX series airfoil with dimensions as defined in Aerodynamic Profile Coordinates - Rotor Blade, GE Drawing 47A382285. The structural interfaces are defined in GE Drawing TBD, Aileron Structural Interfaces. The clearances required are shown in GE Drawing TBD, Aileron Space Allocation.

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3.1.2.2 Tooling

The subcontractor shall provide interface control tooling between the aileron and blade to coordinate the final assembly. One set is to be retained by the aileron subcontractor and the other will be supplied to GE.

3.1.3 Structural Deflection

The aileron structures and hinge assemblies and sealing devices must accommodate differential blade and aileron deflections. These differential deflections may be the result of loading, temperature and moisture content (wood composite blade) either singly or in combination. Blade deflections are given in Table 3.1.3.

3.1.4 Instrumentation Interface

Strain gage instrumentation shall be installed on the aileron structures for evaluation of operational loads. A total of 30 strain gages are to be provided at locations TBD. Appropriate cabling and interface connectors shall be provided to interface with cabling on the trailing edge spar of the blade.

3.1.5 Hydraulic Interface

Hydraulic interfaces for the aileron structure are limited to attachment points and envelope allowances as depicted in Figure 3.1.5, Hydraulic Interface Control Drawing TBD and Aileron Space Allocations Drawing TBD.

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3.1.6 Major Components List

The aileron structures consist of the following major components. Blade 1 and 2 hardware are identical, differentiated only by serial number. Quantity is for a two bladed rotor.

<u>Item</u>	<u>Designation</u>	<u>Qty</u>	<u>Station Location</u>
Aileron Structure	1-A	2	2040 to 2208
Aileron Structure	1-B	2	2208 to 2376
Aileron Structure	2-A	2	1740 to 1890
Aileron Structure	2-B	2	1890 to 2040
Aileron Structure	3-A	2	1440 to 1590
Aileron Structure	3-B	2	1590 to 1740
Hinge Assy - Actuator	1	2	2040
Hinge Assy - Actuator	2	2	1740
Hinge Assy - Actuator	3	2	1440
Hinge Assy - Mid Structure (including Torque Link)	1	2	2208
Hinge Assy - Mid Structure	2	2	1890
Hinge Assy - Mid Structure	3	2	1590
Hinge Assy - Tip	1	2	2376

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3.2 DESIGN REQUIREMENTS

3.2.1 Loads

The aileron structures will be subjected to aerodynamic and inertial (including centrifugal) loads as presented in the following section. These loads are presented as limit loads and fatigue loads in paragraphs 3.2.1.2 and 3.2.1.3, respectively. In addition, the hinge and aileron rib structure will incur loading from the hydraulic actuator as presented in paragraph 3.2.1.4. The coordinate system and method of combining aerodynamic and inertial load is given in paragraph 3.2.1.1.

3.2.1.1 Coordinate System and Load Derivation

Figure 3.2.1.2 illustrates the coordinate system used for the loads definition. The X-direction is parallel to the 60% chord line and coincident with the hinge axis. Y and Z directions are orthogonal in the chordwise and flapwise direction, respectively with origin at the hinge axis. The coordinate system rotates about the X axis (or hinge axis) with the aileron structure. Note that aileron deployment occurs in a negative angular direction (i.e., varies from 0 to -90°). The aerodynamic component of the shear loads has the same origin while inertia components of the running shear load occur at the aileron center of gravity.

The figures in the following sections (3.2.1.2 and 3.2.1.3) present running values of shear (V_x , V_y , V_z) and hinge moment (M_h) in units of lb/ft and ft-lb/ft, respectively. Loads arising from aerodynamic and inertial sources are specified separately because the weight and hence the actual inertia load for the structure is design dependent. Thus, the accelerations are given in G's (multiples of 32.17 ft/sec^2) as a function of span permitting inertial load determination for a particular design. General formula to combine aerodynamic and inertial load contributions in order to obtain the design loads V_x , V_y , V_z , and M_h are as follows:

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$$(1) \dots V_x = w \times g_x$$

$$(2) \dots V_y = w \times g_y + V_{ya}$$

$$(3) \dots V_z = w \times g_z + V_{za}$$

$$(4) \dots M_h = z \times w \times g_y + y \times w \times (g_z - g_x \times \sin h) \\ + k I_{\theta h} + M_{ha}$$

Where:

V_x, V_y, V_z = Running Design Shears which are a function of spanwise position x (lb/ft)

M_h = Running Design Hinge Moment (Torsion), function of x (lb-ft/ft)

V_{ya}, V_{za}, M_{ha} = Aerodynamic Design Loads for limit & fatigue conditions, function of x .

g_x, g_y, g_z, k = Design "g" factors - given as functions of x .

w = Aileron running weight (lb/ft) to be determined as a function of x for the actual design being analyzed.

\bar{y}, \bar{z} = Center of gravity coordinates of aileron structure that rotates about hinge (ft). To be determined as a function of x for actual design.

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$I_{\theta h}$ = Actual aileron running mass moment of inertia
about hinge (slug-ft²/ft).

\angle_h = Inclination of hinge axis in x-z plane
to be determined from blade/aileron
design.

Note that the loads derived via equation 1 to 4 are all per unit of span. They must be integrated with respect to span in order to determine hinge reaction loads and stress resultants at any given cross section. Inertial loads due to concentration masses (e.g., actuators, fittings, etc.) may be determined using equations 1 to 4, using the concentrated weight (in lbs) instead of w and neglecting aerodynamic factors, (Y and Z in equation 4 should be replaced by the concentrated weight's center of gravity position). The aerodynamic and inertial loads account for blade structural deflection.

3.2.1.2 Limit Loads

The aileron structures will be subject to two limit load conditions; hurricane with the ailerons in 0° or -90° position with blade nonrotating, and overspeed with blade rotating. The loads are to be determined using the equations presented in paragraph 3.2.1.1 and Figures 3.2.1.2-A, B, C, and D as follows:

Hurricane (130 mph wind)

(a) Blades Horizontal (Aileron in Line with Main Blade)

$$V_{ya} = 0 \text{ for All } X$$

$$V_{za} \text{ vs } X \text{ in Figure 3.2.1.2-A}$$

$$M_{ha} \text{ vs } X \text{ in Figure 3.2.1.2-A}$$

$$G_x = 0 \text{ for All } X$$

$$G_y = +1 \text{ for All } X \text{ OR } -1 \text{ for All } X$$

$$G_z = -.18 \text{ for All } X$$

$$K = 0 \text{ for All } X$$

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(b) Blades Vertical (Aileron Pitched-90°)

V_{ya} vs X in Figure 3.2.1.2-B

V_{za} vs X in Figure 3.2.1.2-B

M_{ha} vs X in Figure 3.2.1.2-B

$G_x = +1$ for All X or -1 for all X

$G_y = -.18$ for All X

$G_z = 0$ for All X

$K = 0$ for All X

Overspeed Condition

V_{ya} vs X in Figure 3.2.1.2-C

V_{za} vs X in Figure 3.2.1.2-C

M_{ha} vs X in Figure 3.2.1.2-C

G_x vs X in Figure 3.2.1.2-D

G_y vs X in Figure 3.2.1.2-D

G_z vs X in Figure 3.2.1.2-D

$K = 1.7$ for All X

3.2.1.3 Fatigue Loads

A mean and alternating load component define each fatigue load cycle as illustrated in Figure 3.2.1.3-A. The same mean loads will be used for all fatigue cycles, and a probability distribution shall be specified for the alternating loads. The total number of fatigue cycles for the 30 year life of the machine is 400 x 10⁶.

Mean Loads

V_{ya} vs X in Figure 3.2.1.3-B

V_{za} vs X in Figure 3.2.1.3-C

M_{ha} vs X in Figure 3.2.1.3-D

G_x vs X in Figure 3.2.1.3-E

G_y vs X in Figure 3.2.1.3-E

G_z vs X in Figure 3.2.1.3-E

$K = .55$ for All X

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Alternating Loads

Note: The load probability distribution of each load component is determined by multiplying together the corresponding normalized probability distribution (NPD) and load magnitude given below.

(The same NPD is used for all x stations).

V_{yz}	NPD in Figure 3.2.1.3-F Magnitude = .15 x Values in Figure 3.2.1.3-B
V_{za}	NPD in Figure 3.2.1.3-F Magnitude = .15 x Values in Figure 3.2.1.3-C
M_{ha}	NPD in Figure 3.2.1.3-F Magnitude = .15 x Values in Figure 3.2.1.3-D
G_x	NPD in Figure 3.2.1.3-G Magnitude = 1.15 for All x
G_y	NPD in Figure 3.2.1.3-G Magnitude = 1.15 for All x
G_z	NPD in Figure 3.2.1.3-F Magnitude vs x in Figure 3.2.1.3-H
K	= 0 (No Contribution)

3.2.1.4 Actuator Loads

The hydraulic actuator will induce loads into the aileron structure in proportion to the hinge moment being reacted and the mechanism geometry. This geometry is presented in the mechanical interface drawing, GE Dwg # TBD, which results in effective moment arms for the actuator as presented in Figure 3.2.1.4. The load derived from this configuration must be considered in structural and bearing design. Actual/hinge lugs, bearings and local redistribution fittings shall be capable of accepting the full actuator force of 50,000 lbs. without experiencing permanent deformation.

3.2.2 Mass Properties

3.2.2.1 Weight

The accumulated weight of all aileron structures shall be minimized with a goal of 4,000 lbs. broken down as follows:

Aileron structures	1,500	lbs per blade
Aileron hinge	500	lbs per blade

Weight variance from one blade set of ailerons to the other shall be within 1%.

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3.2.2.2 Center of Gravity

The center of gravity of each aileron structure shall be located as close as possible to the hinge axis.

3.2.2.3 Mass Moment of Inertia

The Mass Moment of Inertia about the hinge axis shall not exceed 210.0 slug-ft² for each aileron structure pair (i.e., structures driven by single actuator).

3.2.3 Structural Properties

3.2.3.1 Torsional Stiffness

Aileron structure angular deflection under the following conditions shall be less than 0.5° as measured from inboard to outboard end of the aileron sections driven by an individual actuator. The aileron torsional hinge moment shall be (a) 310 ft-lb/ft from $r/R = .60$ to $.75$, (b) 270 ft-lb/ft from $.725$ to $.85$, and (c) 180 ft-lb/ft from $.85$ to $.99$. The aileron structure shall be assumed fixed (cantilevered) at the actuator end.

3.2.3.2 Resonant Frequencies

Individual aileron structures when mounted to stiff hinges and actuator shall have suitable stiffness and mass properties such that bending resonant frequencies are at least 20Hz. The torsional resonant frequency shall exceed 45 Hz when cantilevered at the actuator location. (Not including actuator stiffness.)

3.2.4 Construction

3.2.4.1 Sealing and Fairing

The aileron structures shall have a sealing system to minimize air flow between high and low pressure airfoil surfaces especially in the non-deployed (0°) position. Suitable aerodynamic fairing to minimize drag shall be provided around any protruberance outside the airfoil geometry. The proper drag coefficient, based on the frontal area of the faired protruberance shall not exceed 0.5.

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3.2.4.2 Damage Tolerant Design

The design shall consider current damage tolerance technology. To the maximum extent possible considering the economies of aileron fabrication, the structure shall be designed fail safe-crack arresting. Multi-load path independent structure, where it would impact fabrication cost minimally, is preferable to single load path structure.

3.2.4.3 Material

The aileron shall be fabricated of any material combinations with known engineering characteristics mutually acceptable by GE and subcontractor.

3.2.4.4 Surface Condition

The aileron finished surface smoothness shall be equivalent to 150 ± 50 rms. Variations on airfoil profile (GE Dwg. 47A382285) shall be within $\pm .030$ inch of basic contour. Surface contour waviness shall not exceed .030 inch within a 5 inch dimension either spanwise or chordwise.

3.2.4.5 Finish

The aileron structures shall be finished in accordance with the color and finish requirements of GE Spec 47A380048. Specification for Material Finishes, MOD-5A structure.

3.2.4.6 Venting & Draining

The exterior skin of the ailerons shall be sealed to preclude entrance of moisture. Provision for removal of condensed water and venting of aileron structure interior shall be made at the outermost blade station of each aileron section. Drains shall preclude entrance of insects or particulates.

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3.2.4.7 Lightning

The aileron structures shall provide a conductive path to ground to minimize damage in the event of a lightning strike. Non-conductive surfaces of the aileron shall be protected with a conductive screen with a cross sectional area in any one foot equivalent to AWG #4 copper wire. Conductive screen should be as close as possible to the external surfaces of airfoil surface, preferably, just inside of protective weather barrier. The trailing edge shall also be protected with a conductor equivalent to AWG #4 copper wire. All surface conductors shall be interconnected and connected to a jumper across each hinge point (i.e., bearings) which shall be equivalent to an AWG #6 copper wire.

Aileron structures with protection equivalent to that described in this paragraph (3.2.4.7) are suitably protected against lightning strikes of paragraph 3.3.3.

3.2.4.8 Bearings

The aileron hinge bearings shall be self-aligning spherical plain bearings with 90% reliability (L-10 Life) for the life and operation specified in paragraphs 3.2.5.1 and 3.2.5.2. The bearing shall be a maintenance free type with seals and grease filled for environmental protection.

3.2.4.9 Corrosion

The ailerons will be exposed to all weather conditions, including seacoast. External surfaces shall be compatible with exposure to sun, rain, snow, sleet, etc. All components shall be moisture-proofed, especially internal components and surfaces, to prevent corrosion failures due to humidity, condensation, salt spray, etc. Protective coatings will be used and maintained on a schedule related to the durability of the coating. Design features susceptible to galvanic corrosion shall be avoided, and when necessary, suitable protection features shall be utilized.

3.2.5 Life and Operation

3.2.5.1 Life

The aileron design service life shall be no less than 30 years. Periodic replacement of components or other maintenance is permitted to meet the life requirement.

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3.2.5.2 Function Operation

TBD

3.3 ENVIRONMENT

The aileron shall be subject to environment conditions as described in the following paragraphs.

3.3.1 Temperature

The ailerons shall be capable of survival in temperatures from -40 degrees C to +49 degrees C (-40 degrees to +120 degrees F) ambient air, and operation from -30°C to +40°C (-22°F to +104°F) ambient air.

3.3.2 Precipitation

The ailerons shall be subjected to the following precipitation environments after installation:

Rain:	4 inches/hour
Hail:	1.0 inch dia., 50 lb/cu. ft., 66.6 ft/sec terminal velocity (for horizontal and vertical surfaces)
Ice:	2.0 inches, 60 lb/cu. ft., on all external surfaces non-operating
Snow:	41 lb/sq. ft.

3.3.3 Lightning

The ailerons shall be subjected to lightning strikes as defined in Figure 3.3.3.

3.3.4 Projectile Impact

The ailerons shall be subjected to impact of 4 lb. birds moving at 35 mph. Functional failures are not permitted, but local yielding is allowed.

3.3.5 Solar Radiation

The ailerons shall be subjected to sunlight at a maximum insolation rate of 363 btu/ft² hr. for 4 continuous hours daily.

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3.4 DESIGN CRITERIA AND ANALYSIS

The aileron will conform to standard requirements for control surfaces of manned aircraft. Information in MIL-HDBK-5C, MIL-HDBK-17, MIL-HDBK-23, or equivalent regarding materials, fasteners and methods of analysis is suitable for aileron design. The summary design criteria present below apply and supercedes other factors of safety unless exceptions are approved by GE.

Limit:	Factor of Safety to yield = 2.0 (min), net section
Stability:	Factor of Safety to critical stress = 1.5 (min)
Fatigue:	Miner's Rule $\sum \frac{n_i}{N_i} = 0.3^* \text{ (max)}$

*For the mean of the S-N data applicable to the design detail.

When necessary, the subcontractor shall identify and perform fatigue testing for items lacking similarity to a design data base. Fatigue data shall be reported to GE for the S-N curve used to calculate Miner's cycle ratio summations, whether the data is from testing for the aileron under this contract or from pre-existing sources, such as MIL-HDBK-5C or literature. The vendor may use more conservative criteria if indicated by his standard practices or judgement, pending GE review and approval.

The material toughness at the cold extreme shall be used to describe tolerance to cracks. This also contributes to inspection interval selection. However, the design is to be fail-safe (see section 3.2.4.2 Damage Tolerant Design), and not dependent upon the successful implementation of inspection intervals. Inspection is intended to detect damage due to vandalism, abnormal conditions, bird strikes or other unforeseeable events. The combined effect of temperature and moisture on composite materials and adhesive strength must be described.

The vendor must clearly account for load paths in various configurations, welding effects (if any), eccentricities, stress concentration and joint prying actions. The vendor will provide in his proposal a statement of capabilities, methods and procedures for design analysis. Exceptions in the above criteria, additional analysis required and standard procedures are to be described.

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3.5 DESIGN REVIEW AND DOCUMENTATION

The design of the ailerons shall be subject to review and approval by General Electric, along with supporting analyses, to verify conformance to the requirements of this specification. Adequate documentation of design analysis, drawings, specifications and quality assurance shall be provided to General Electric for review and approval. A preliminary design review (PDR) shall be conducted to review all preliminary design work accomplished prior to hardware or tooling fabrication. The review will address preliminary work completed in areas as delineated in the following paragraphs. A final design review (FDR) will be held to demonstrate that the design is ready for production. All critical analyses requested in the PDR will be updated and finalized for FDR. All detail design and test results shall be reviewed.

3.5.1 Drawing and Specifications

The subcontractor shall prepare all drawings and specifications required for the fabrication, inspection and delivery of ailerons for the MOD-5A Wind Turbine Generator Program. The drawings shall conform to the requirements of paragraph 3.5.1.1. Three (3) prints and one (1) reproducible copy of all assembly and detail drawings shall be forwarded to GE within five (5) working days after their release. All changes to these drawings that affect the performance, interface, safety or reliability shall be approved by GE. All changed drawings shall be forwarded to GE within five (5) working days after change.

3.5.1.1 Standard

All engineering drawings shall conform to American National Standard ANSI Y 14.1 (drawing sheet size and format). The set of drawings shall provide the necessary design, engineering, manufacturing and quality support information directly or by reference to enable the procurement, without additional design effort or recourse to the original design activity, of an item that duplicates the physical and performance characteristics of the original design. These drawings shall not provide manufacturing process information unless this information is essential to accomplish manufacture of an identical item by other than the original source.

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The final drawings shall not contain references to specifications, procedures, manuals and processes that are company proprietary and/or not available through conventional literature sources unless complete definitions for each specification, procedure, manual and process are delivered without restriction to General Electric in reproducible form.

3.5.1.2 Adequacy

The drawings shall include details of unique processes essential to design and manufacture; dimensional and tolerance data; critical manufacturing assembly sequences; schematics, mechanical and electrical connections; physical characteristics, including form and finishes; details of material identifications; inspection, test, and evaluation requirements and criteria; necessary calibration information; and quality control data.

3.5.2 Analysis Summary

An analysis summary report shall be provided for review and approval by General Electric. Analysis presented shall address as a minimum; fatigue and limit stresses, load and thermal deflections, dynamics, weights, bearings and lubrication, failure modes and effects and life verification. Calculations of mass properties (weight distribution, lumped masses, center of gravity, moments of inertia), structural stiffness characteristics (EI, GI) and resonant frequencies (bending and torsional), shall be provided suitable for use in finite element modeling. The analysis shall substantiate conformance to the requirement of this specification. Three copies and one reproducible copy shall be provided.

3.5.3 Test Plans and Reports

Test plans and procedures shall be generated by the subcontractor for the aileron tests described in this specification and criteria as developed during preliminary design. Test reports shall be prepared by the subcontractor in a timely manner fully documenting test results and conclusions. Test plans, procedures, and reports shall be provided to General Electric for review and approval.

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3.5.4 Maintenance

Operation and maintenance requirements and spare parts recommendations shall be documented and provided to General Electric for review and approval. Complete inputs on ailerons for operation and maintenance manuals shall be provided.

3.6 MAINTAINABILITY

3.6.1 Maintenance Requirements

Periodic scheduled maintenance shall be considered in the design of the ailerons. The nominal interval shall be 6 months between inspections, with maintenance performed only as required. Periodic maintenance may be used for servicing and lubrication functions that do not require automatic operation and for detection and repair of non-critical failures such as minor leakage.

3.6.2 Maintenance Features

Access and support features shall be provided on the ailerons to facilitate inspection and maintenance operations. Due consideration shall be given to the work environment of the ailerons when installed on the WTG rotor. Minimum required features are as follows:

3.6.2.1 Lifting Attachment Point

Aileron structures shall be provided with positive mechanical attachment points for lifting and guiding the structure in a vertical and horizontal position. Primary intent of said points shall be for removal and installation of aileron structures from/on the WTG rotor during the service life of the WTG with the rotor orientation perpendicular to the ground. (See structural interface drawing #TBD.)

3.6.2.2 Service Tiedowns

The aileron hinge assembly shall provide positive mechanical attachment points for tethering and positioning a service access platform. Primary intent of tiedowns is to prevent lateral relative motion between blade and platform with platform weight taken by support cables.

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3.6.2.3 Access Covers

Removable covers shall be provided for access to mechanical and hydraulic components. Positive retention mechanical fastener, hinged covers and/or tether lines shall be utilized in the design of access covers.

3.6.2.4 Mechanical Service Equipment

A mechanical interface and mechanical deployment device and structural lock shall be provided by the subcontractor to deploy and lock the aileron structures in various attitudes from 0 to -90° for servicing. When deployed at the -90° position, a structural lock (in addition to the deployment device) shall be provided to latch the aileron structure in position after which the deploying device shall be removable.

3.6.2.5 Bearing Maintenance

The hinge assemblies shall be designed to permit removal and replacement of a single aileron structure without releasing another. A temporary 'jury strut' is permitted if a single hinge pin is utilized for two structures. Design of hinges and bearing assemblies shall minimize activities required for replacement of bearing with aileron installed on rotor. Bearing assemblies shall be replaceable without requiring removal of aileron structure from rotor.

3.6.3 Maintenance Loads

Limit loads for each of the features described in paragraphs of Section 3.6.2 are 'TBD'.

3.7 LIFTING, HANDLING AND SHIPPING

3.7.1 Lifting

The aileron structures shall incorporate provisions for lifting of finished sections in both a horizontal and a vertical attitude from the ground upward. This may be accomplished with the blade itself or by means of a fixture to be available in the field. The lifting and support points and safety securing items shall be specified on detail drawings. Any special lifting brackets, hardware, etc., shall be provided.

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3.7.2 Handling and Shipping

The ailerons shall have provisions for being handled and being cradled for shipping. Shipping environments shall include those encountered by rail and highway and overseas transportation.

3.8 IDENTIFICATION MARKINGS

Identification markings in an easily accessible area shall be in accordance with standard commercial practice and shall include the following:

- a) GE part number TBD
- b) Vendor's name, symbol, or code identification
- c) Vendor's part number, lot number and serial number

3.9 TESTING

3.9.1 Proof Test

A proof of design test shall be conducted on a pair of aileron structures driven by a single actuator. The proof test section(s) shall not be used as prime hardware. The proof test shall simulate operating and limit loads at various aileron deployment angles with the supporting strongback simulating associated blade/aileron hinge deflections. Strain measurements shall be made to verify analysis conducted on the structure. The test sections shall be delivered for use in a functional testing of the aileron system.

Torsional stiffness and structural deflection measurements shall be made. Structure bending and torsional resonant frequencies shall be measured.

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3.9.2 Functional Test

A functional test of the aileron structures, previously used in the proof test, mated to a WTG blade section provided by GE shall be conducted. The test shall evaluate the aileron operation under various loading conditions and validate the interface between the blade and ailerons.

Torsional stiffness and structural deflection measurements shall be made. Structure and system bending and torsional resonant frequencies shall be measured.

3.9.3 Mass Properties

Mass property determination consisting of weight, center of gravity and Mass Moment of Inertia shall be made on all delivered units in order to verify conformance to requirements herein.

3.9.4 Non-Destructive Testing

Design shall include adequate use of non-destructive testing techniques to assure material integrity in critical areas.

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SECTION 4.0
QUALITY ASSURANCE PROVISIONS

4.1 DOCUMENTATION AND REVIEW

4.1.1 Design Review

All drawings, specifications, and supplier process descriptions intended for use on this contract will be submitted to General Electric for review after approval by the subcontractor. Three (3) copies of each document will be sent to GE Subcontracts within five working days after issuing.

GE will notify the subcontractor of any disapproval within ten working days.

4.1.2 Non-Destructive Testing

Designs to include adequate use of non-destructive testing techniques (e.g., ultrasonic, radiographic, magnetic particle/penetrant inspections, etc.), to assure material fidelity in highly stressed or critical parts. Descriptions of these techniques will be reviewed by GE Quality Assurance.

4.1.3 Joining Systems

Procedure specifications are required for fastening and joining systems (e.g., riveting, welding, brazing, bonding, screw attachments, etc.) and must identify accept/reject criteria and, when applicable, include torque values. Specifications must be submitted to GE for approval.

4.1.4 Design Changes

Revisions to the above documents must be submitted to GE for review within five working days after issuing. GE will notify the subcontractor of any disapproval within ten working days.

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4.1.5 Responsibility for Inspections

The subcontractor shall be responsible for the performance of all inspections and tests specified herein. The vendor shall utilize his own facilities or any commercial laboratory acceptable to GE. GE reserves the right to perform any of the inspections and tests set forth in this specification where such inspections and tests are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 SYSTEM SAFETY PLAN

4.2.1 GE Approval

The subcontractor shall provide a system safety plan for the development and fabrication of the WTG ailerons. This plan must be submitted to GE for approval.

4.2.2 Procedure

The plan must incorporate a procedure to systematically review each detail and assembly drawing for potential hazards that could occur during the fabrication, handling and transporting of the WTG ailerons. The subcontractor will identify (by drawing number) features of the design that may tend to exhibit more than normal risks. These designs will be selected for an in-depth review by the subcontractor and GE to determine the risk assessment.

Specifically, the designs shall be critiqued for areas that could cause hazardous conditions or catastrophic failures that would result in damage to WTG equipment or injury to personnel.

4.3 RELIABILITY

4.3.1 Participation

Participation in the subcontractor's in-house reviews shall include subcontractor personnel from System Safety, Reliability, and Quality Assurance.

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4.4 PRODUCT ASSURANCE

4.4.1 Program Plan

The subcontractor shall implement and maintain a product assurance program for this subcontract in accordance with the requirements shown herein. These Quality Assurance Provisions shall apply to all deliverable hardware.

The subcontractor shall provide a Product Assurance Plan which describes procedures to ensure compliance with the requirements shown herein. The plan shall be submitted to GE for approval and shall include:

4.4.1.1 Organization

A description of the subcontractor's organization which implements the Quality Assurance Program.

4.4.1.2 Manufacturing Plan

A Manufacturing Plan indicating the flow of fabrication and assembly operations and related inspection and test points. GE will use this flow plan to identify in-process test and inspection points that are to be witnessed by a GE Quality Assurance Representative. A flow diagram is to be included.

4.4.2 Management

4.4.2.1 Quality Director

The subcontractor shall designate one individual responsible for directing and managing the product assurance function. The subcontractor's Product Assurance Director shall have direct access to higher management.

4.4.3 Customer Review

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4.4.3.1 Product Assurance

The Product Assurance System of the subcontractor is subject to continuous evaluation, review and verification by GE.

4.4.3.2 Facilities Survey

A Quality survey will be conducted at the subcontractor's facility and at any sub-tier vendor (as required) by GE Product Assurance.

4.4.4 Quality System

The subcontractor shall maintain an effective and timely quality system to provide that defects or other unsatisfactory conditions are discovered and corrected at the earliest practical point. The system shall provide recorded evidence of quality in the form of inspection and test results. The subcontractor shall make this recorded evidence of quality available to GE.

4.5 DRAWING AND CHANGE CONTROL

4.5.1 Product Configuration

The subcontractor shall ensure that articles are fabricated, inspected, and tested to the latest applicable drawing or specification, and that necessary changes are accomplished and so evidenced on the inspection records of the part, component, or assembly.

4.6 PROCUREMENT

4.6.1 Supplier Control

The subcontractor shall be responsible for adequate and effective control over procurement sources to ensure that materials, supplies, components and services purchased for use on this contract meet all quality requirements. Adequate records of inspections and tests performed at the source shall be maintained.

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4.7 CUSTOMER INSPECTION

4.7.1 GE Source Inspection

The subcontractor shall notify GE Subcontracts five days in advance of any mandatory inspection/test point identified to the subcontractor by GE from the flow plan referenced in paragraph 4.4.1.2. GE reserves the right to inspect any or all of the materials included in this order, at the subcontractor's plant.

4.7.2 GE Test Observation

Two GE representatives shall be permitted to witness any or all tests at the vendor's plant or other test locations. GE Procurement shall be notified 48 hours in advance of testing.

4.8 MATERIAL HANDLING

Adequate methods and facilities shall be established for controlling the identification, handling and storage of fabricated materials.

4.9 MATERIALS CONTROL

Materials used for article fabrication shall be inspected, tested (e.g., chemical and physical tests) and documented to determine conformance to applicable specifications and drawings. Records of actual test results shall be identified with the particular materials. The subcontractor shall separate, and prevent the use of materials which do not conform to requirements or which are awaiting completion and receipt of test results.

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4.10 INSPECTION AND TESTS

The subcontractor shall perform sufficient inspections and tests of all parts, components, and assemblies to ensure, prior to test or delivery, that all articles conform to applicable drawings or specifications with respect to all details, such as workmanship, finish, construction, functional performance, weight interchangeability, identification, and marking.

These inspections and tests shall include receiving, processing, fabrication, assembly, end item, and shipping phases. Written inspection and test procedures shall be prepared to make clear the details of the inspection and measuring equipment required, the detailed operations to be performed, and the criteria for determining quality conformance or rejection of articles. Inspection and test procedures will be subject to GE review.

4.11 PROCESS CONTROL

4.11.1 Procedures and Certifications

The subcontractor shall establish those inspections and controls over processes to ensure compliance with quality requirements which are not readily detectable or measurable by inspection and test of finished articles. When approval or certification of special processes, operating personnel, special equipment or procedures, is required by the drawing or specification, the subcontractor shall obtain the necessary approvals or certification prior to processing the articles.

4.11.2 Records

Records of in-process inspections and controls may be used as evidence of quality of end items, and may reduce, but not eliminate, further end-item inspection.

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4.12 NON-CONFORMING ARTICLES

4.12.1 Procedures

The subcontractor shall provide for the review of non-conforming articles to control their use as articles offered for test or delivery. Non-conforming articles shall be identified and separated from normal work operations. When the subcontractor wishes to offer the non-conforming articles for test or delivery, the following procedures shall be followed:

4.12.1.1 Review Board

The subcontractor shall establish a Review Board (RB) which will review all non-conforming articles. The RB shall consist of a cognizant engineer and a quality assurance representative. Recommendations to accept non-conforming articles by the RB shall be by mutual agreement of the members. RB recommendations shall be documented and the documentation shall show the details of the non-conformity and the appropriate disposition, such as repair, use as is, or scrap.

4.12.1.2 GE Review

No non-conformance may be accepted without GE's written approval. Subcontractor recommendations to accept shall be submitted in writing to GE. GE will then, within seven (7) working days, notify the subcontractor in writing of approval or disapproval of recommended disposition. Emergency situations may be handled by telephone, but follow-up documentation is required for final disposition.

4.12.1.3 Equipment Log

The subcontractor shall include a copy of each "use as is" and rework not to drawing non-conformance report and the documented RB action in the Equipment Log.

4.12.1.4 Records

Copies of all non-conformance reports should be maintained on file at the subcontractor's facility and are subject to review by GE Quality Assurance Representative.

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4.13 INSPECTION, MEASURING AND TEST EQUIPMENT

4.13.1 Calibration System

The subcontractor shall provide and maintain suitable inspection, measuring, and test equipment of range, accuracy and type necessary to ensure conformance of articles to subcontract requirements. At intervals established to ensure continued accuracy, each unit of inspection, measuring and test equipment shall be calibrated against certified standards which have known, valid relationships to the National Bureau of Standards. Records of calibrations performed shall be maintained. The due date, or other identification attesting to the due date, of the next calibration shall be displayed on each unit of inspection, measuring and test equipment.

4.13.2 Tool Control

Tools, gages, jigs, or fixtures which control dimensions, contours, or locations affecting quality characteristics, shall be initially checked for accuracy prior to use. Periodic check and recalibration shall be made at predetermined intervals to ensure their continued accuracy.

4.13.3 Contour Control

The Subcontractor shall design and build inspection tooling to verify the aileron contour.

4.13.4 GE Design Review

Designs for tooling used as a media of inspection shall be submitted to GE for review and approval by Quality Assurance Engineering prior to manufacture and use.

4.14 INSPECTION STATUS INDICATION

The subcontractor shall maintain a system for indicating the inspection status of articles. This shall be accomplished by means of stamps, seals, decals, or other methods on individual articles, tags, routing cards, move tickets, or other normal control devices attached to the articles or their containers. Details of this system are to be submitted to GE for approval.

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4.15 PRESERVATION, PACKAGING, PACKING AND SHIPPING

The subcontractor shall ensure that all deliverable articles are complete and that necessary documentation has been provided to GE. The subcontractor shall maintain adequate control of the preservation, packaging, and shipping operations to ensure that the quality of the fabricated articles is maintained, and that damage, deterioration, loss and substitution are prevented. The packing and marking of articles shall comply with Interstate Commerce Commission rules and regulations and shall ensure safe arrival and ready identification at destination.

4.16 INSPECTION AND TEST RECORDS

The subcontractor shall maintain adequate records of all inspections and tests performed. The records shall provide evidence that the required inspections and tests have been performed, including part or component identification, inspection or test involved, nature of defects, and basic causes for rejection. These datum must cover both conforming and defective items. Records of all inspections and tests shall be made available to GE for review.

4.17 EQUIPMENT LOG FOR DELIVERABLE AILERONS

4.17.1 Manufacturing History

Throughout the inspection, assembly, and test of deliverable WTG ailerons, the subcontractor shall maintain a log as a means of documenting the continuous history of the item.

4.17.2 Equipment Log Format

The Equipment Log is to include the drawing number of each unique part and subassembly, the drawing revision, Review Board (RB) number when applicable, and indicate acceptable assembly and tests.

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4.18 FAILURE REPORTING

For each functional failure occurring in the project, the subcontractor shall prepare an individual failure report. This report shall contain a description of the circumstances of the failure, analysis of causes, recommendations for corrective action, and corrective action taken. An interim issue of the reports issued each month shall be summarized in the Monthly narrative Status Report. The status of failure reports still open (no final issue) from previous Monthly Reports shall be stated.

4.19 CUSTOMER (GE) FURNISHED EQUIPMENT

4.19.1 Inspection

When equipment is furnished by GE, the subcontractor shall:

- * Upon receipt, inspect to detect damage in transit.
- * Inspect for completeness and proper type, size or grade.
- * Provide for protection, periodic inspections, and controls necessary to preclude damage or deterioration during handling or storage.
- * When contractually required, perform functional testing prior to further processing or installation to determine satisfactory operation.

4.19.2 Deficient CFE

The subcontractor shall report to GE any damage, malfunction, or other problems that make the CFE unsuitable for use. The subcontractor shall also determine and report the probable cause and necessity for withholding such equipment from use. The subcontractor shall ensure that such equipment is handled in such a way as to prevent further damage.

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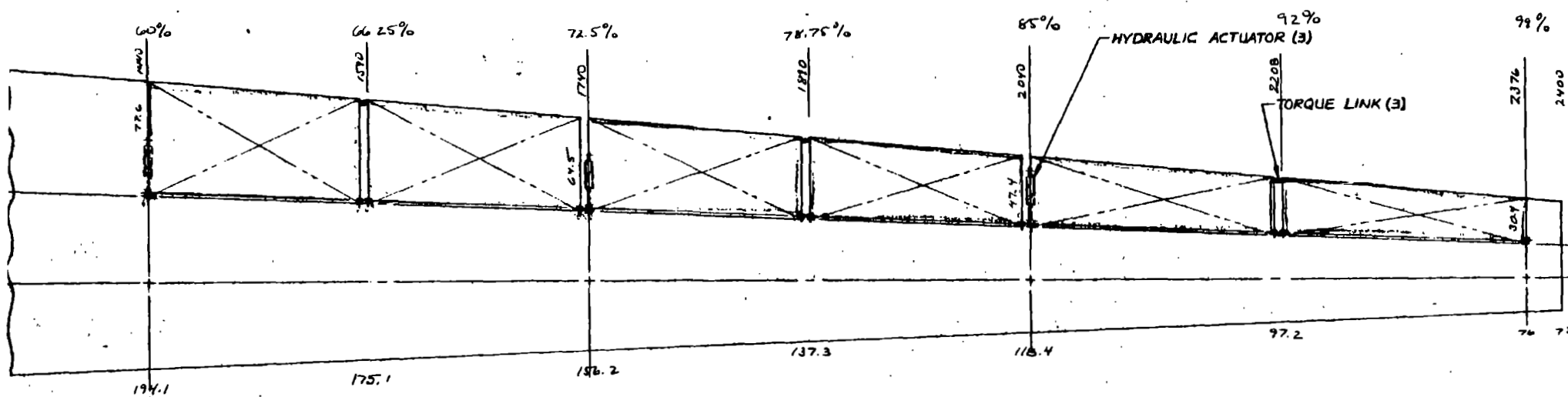
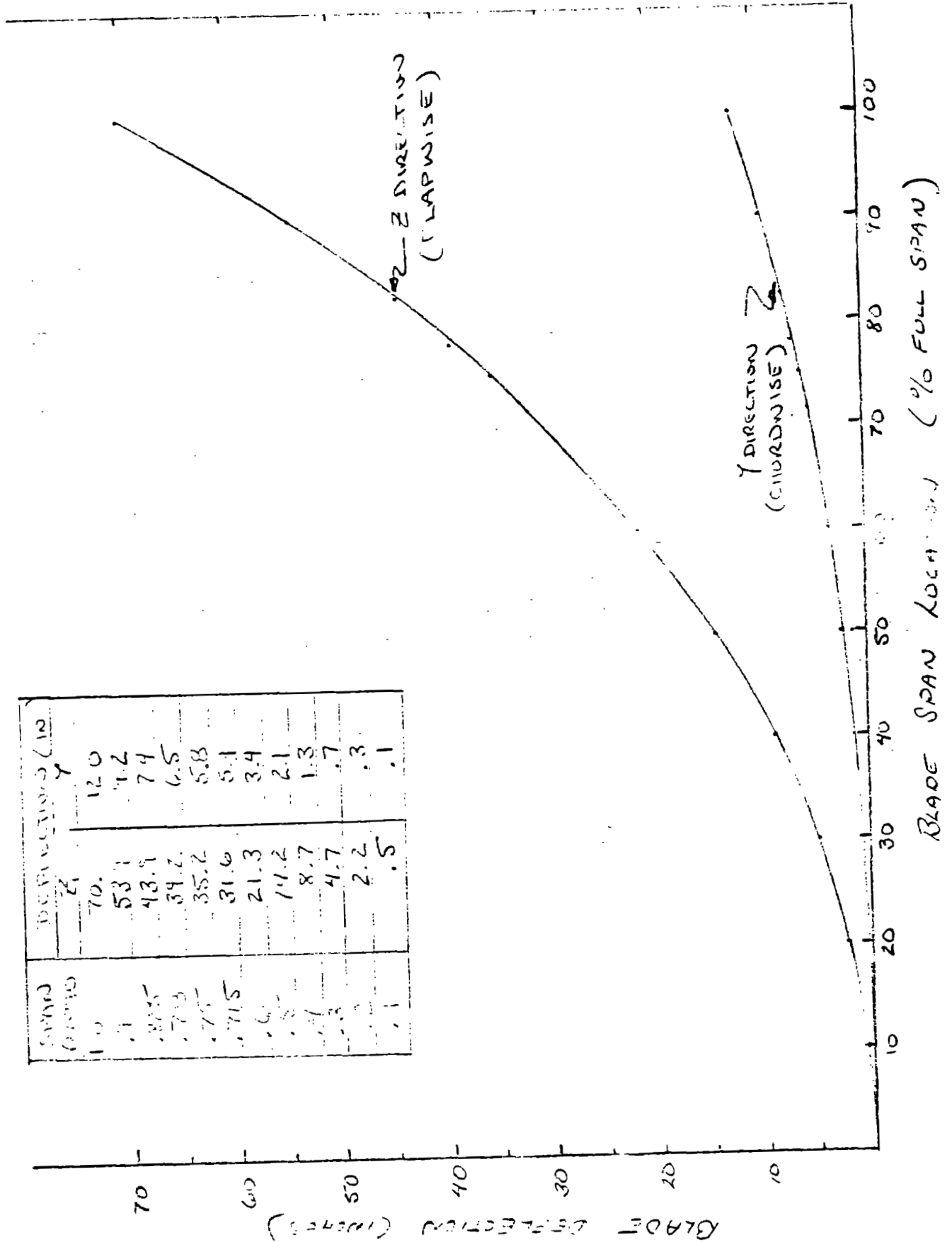


FIG. 3.1.1
(6 AILERON SECTIONS & 3 ACTUATORS ON END OF PAIRS)

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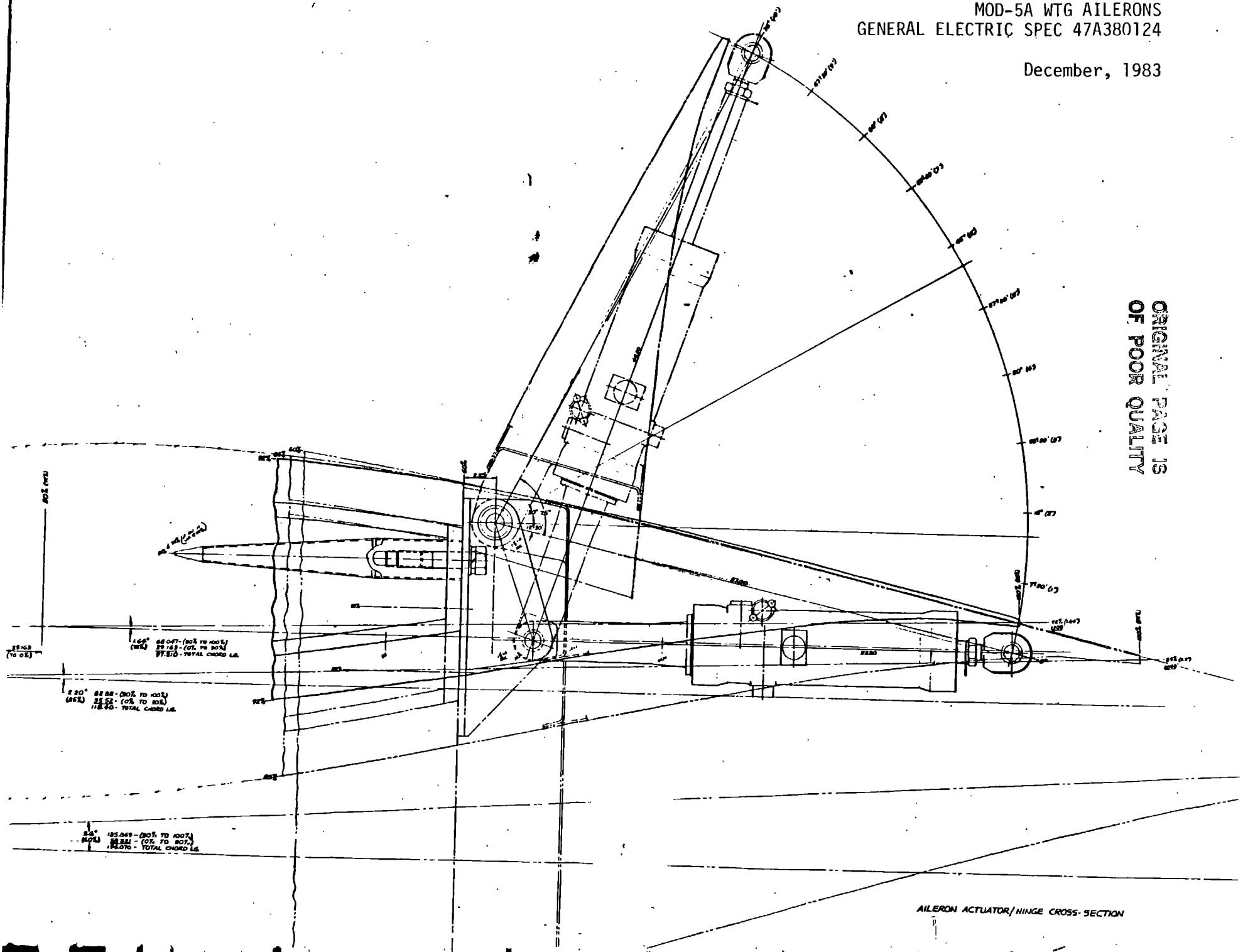
FIGURE 3.1.3 - BLADE DEFLECTION (INCHES)



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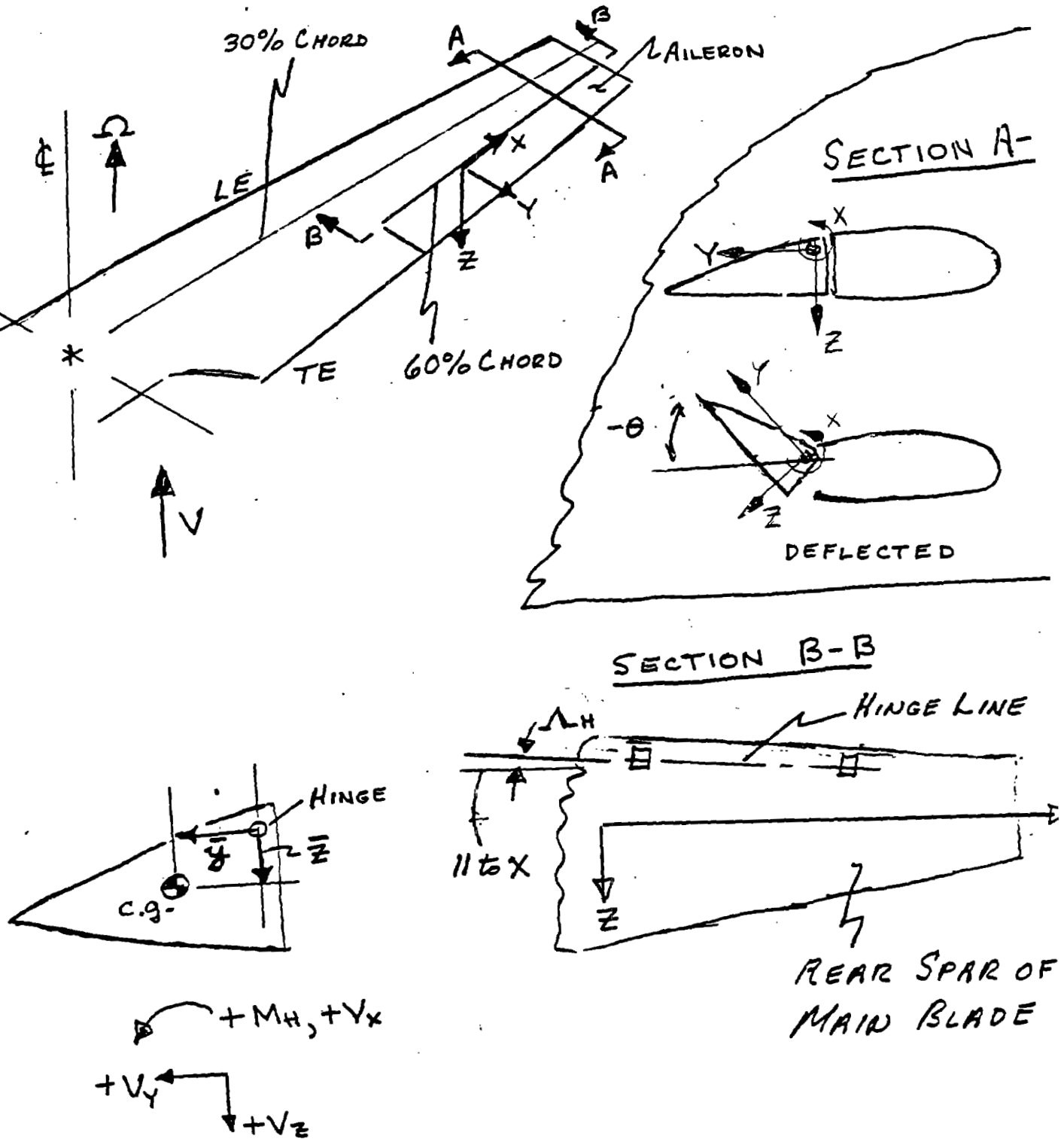


AILERON ACTUATOR/HINGE CROSS-SECTION

FIGURE 3.2.1.2 - COORDINATE SYSTEMS

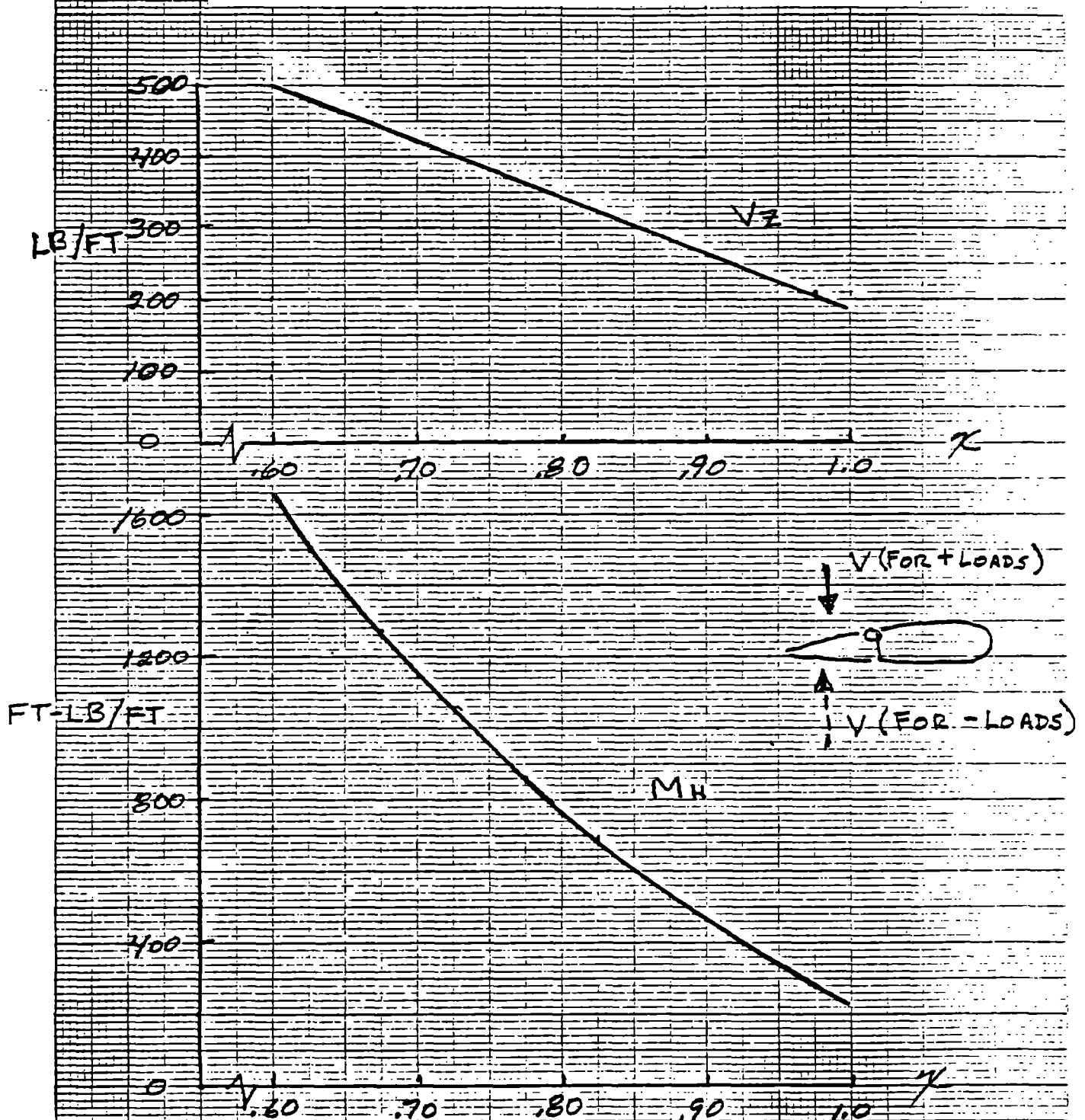
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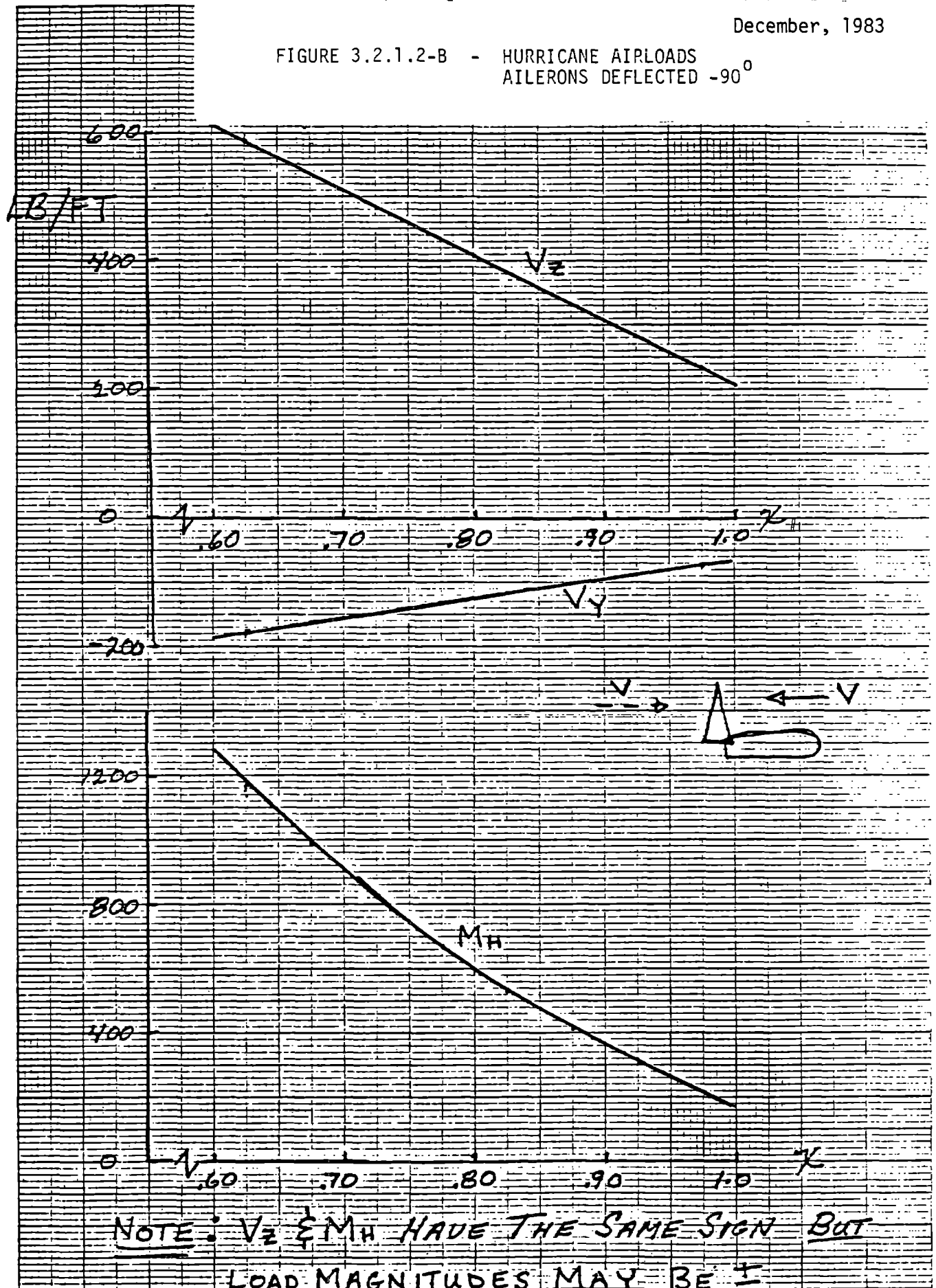
FIGURE 3.2.1.2-A - HURRICANE AIRLOADS
AILERONS UNDEFLECTED



NOTE : V_z & M_H HAVE SAME SIGN BUT
LOAD MAGNITUDES ABOVE MAY BE \pm

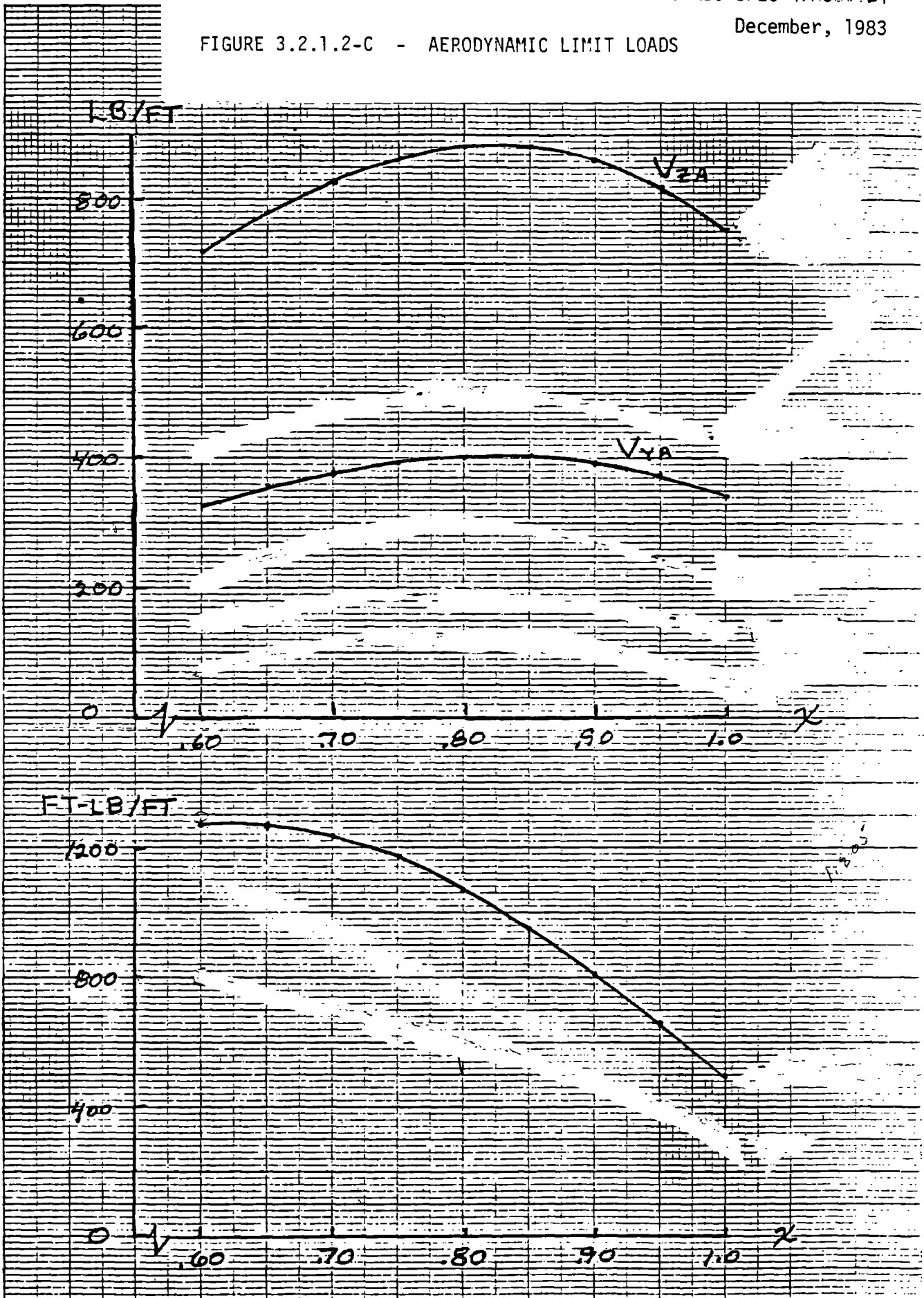
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FIGURE 3.2.1.2-B - HURRICANE AIRLOADS
AILERONS DEFLECTED -90°



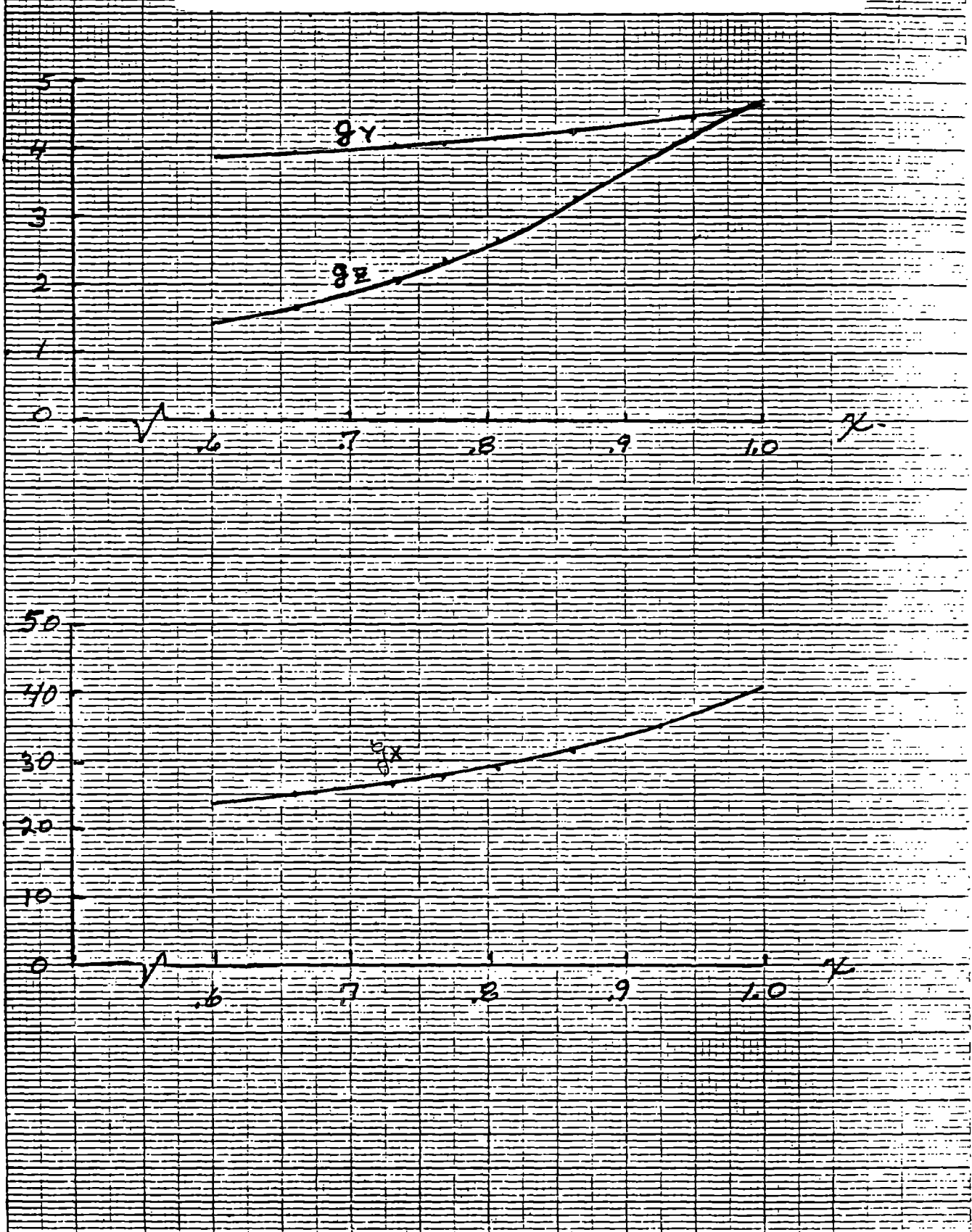
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FIGURE 3.2.1.2-C - AERODYNAMIC LIMIT LOADS



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FIGURE 3.2.1.2-D - G-FACTORS FOR LIMIT LOADS



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FIGURE 3.2.1.3-A - TYPICAL FATIGUE CYCLE

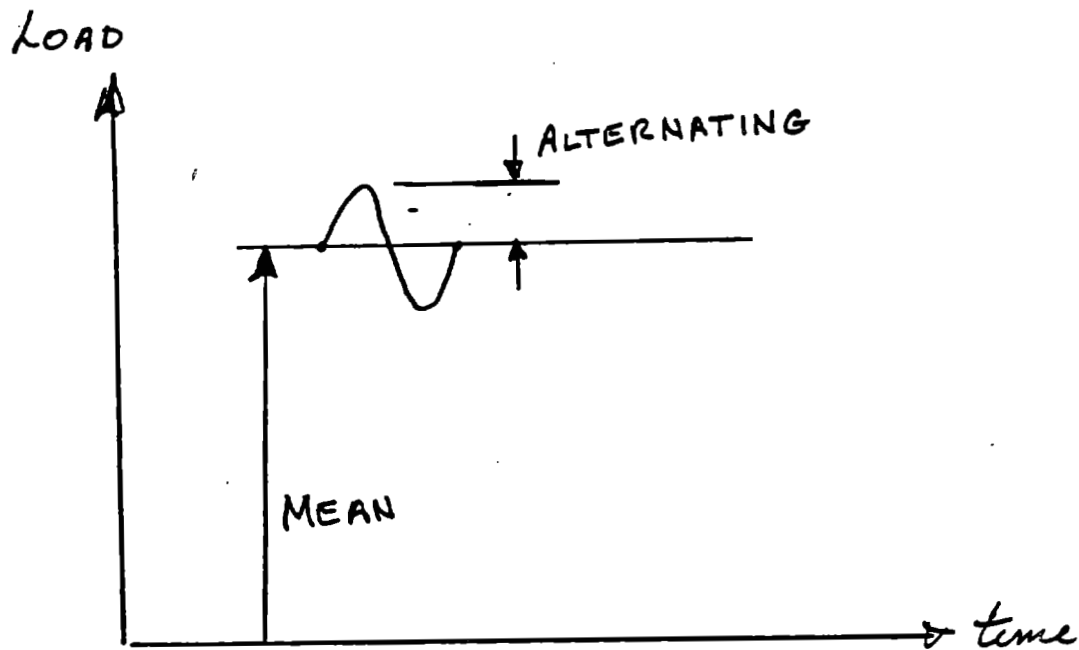


FIGURE 3.2.1.3-C - AILERON NORMAL FORCE $\sim V_Z A$

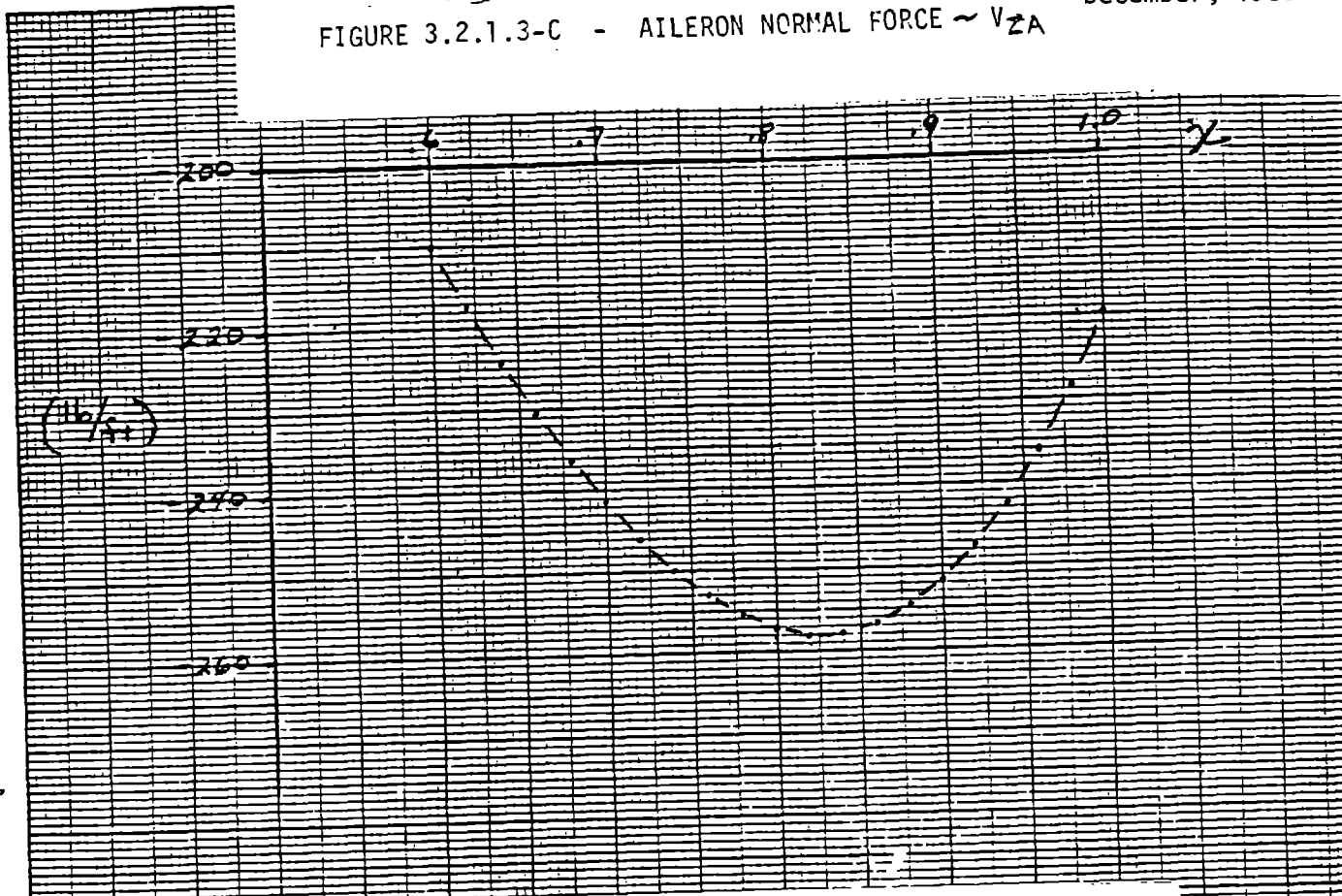
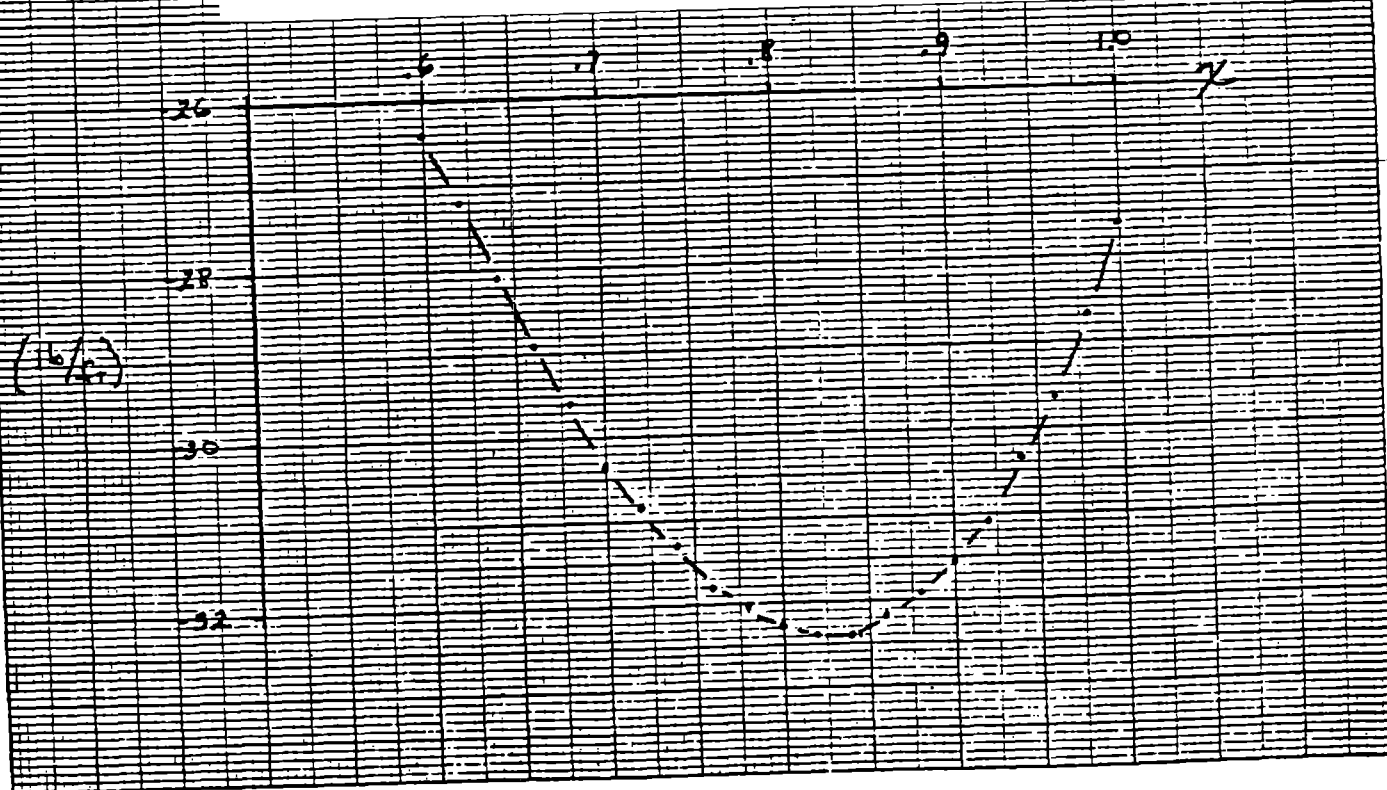
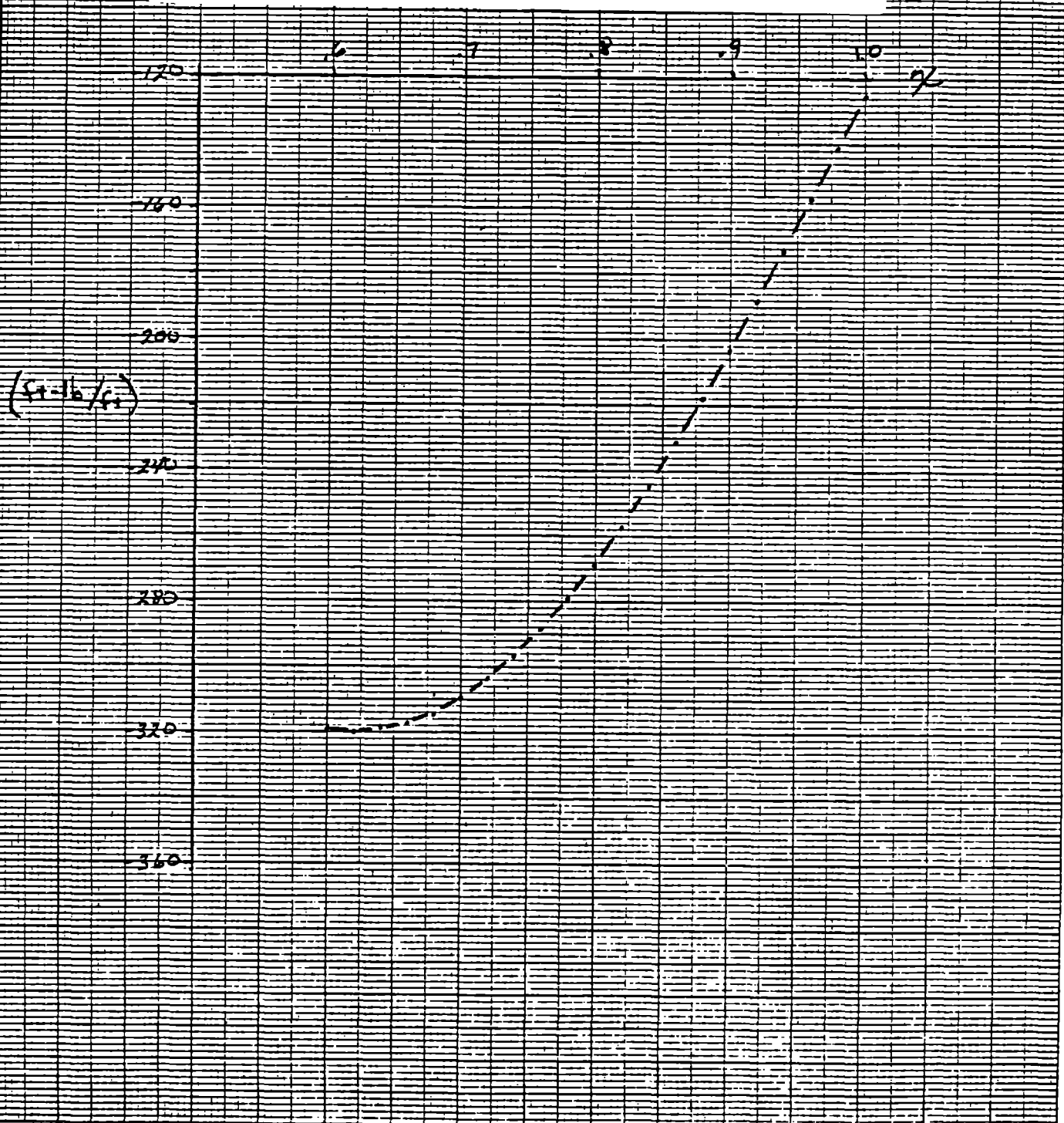


FIGURE 3.2.1.3-B - AILERON LATERAL FORCE V_{YA}



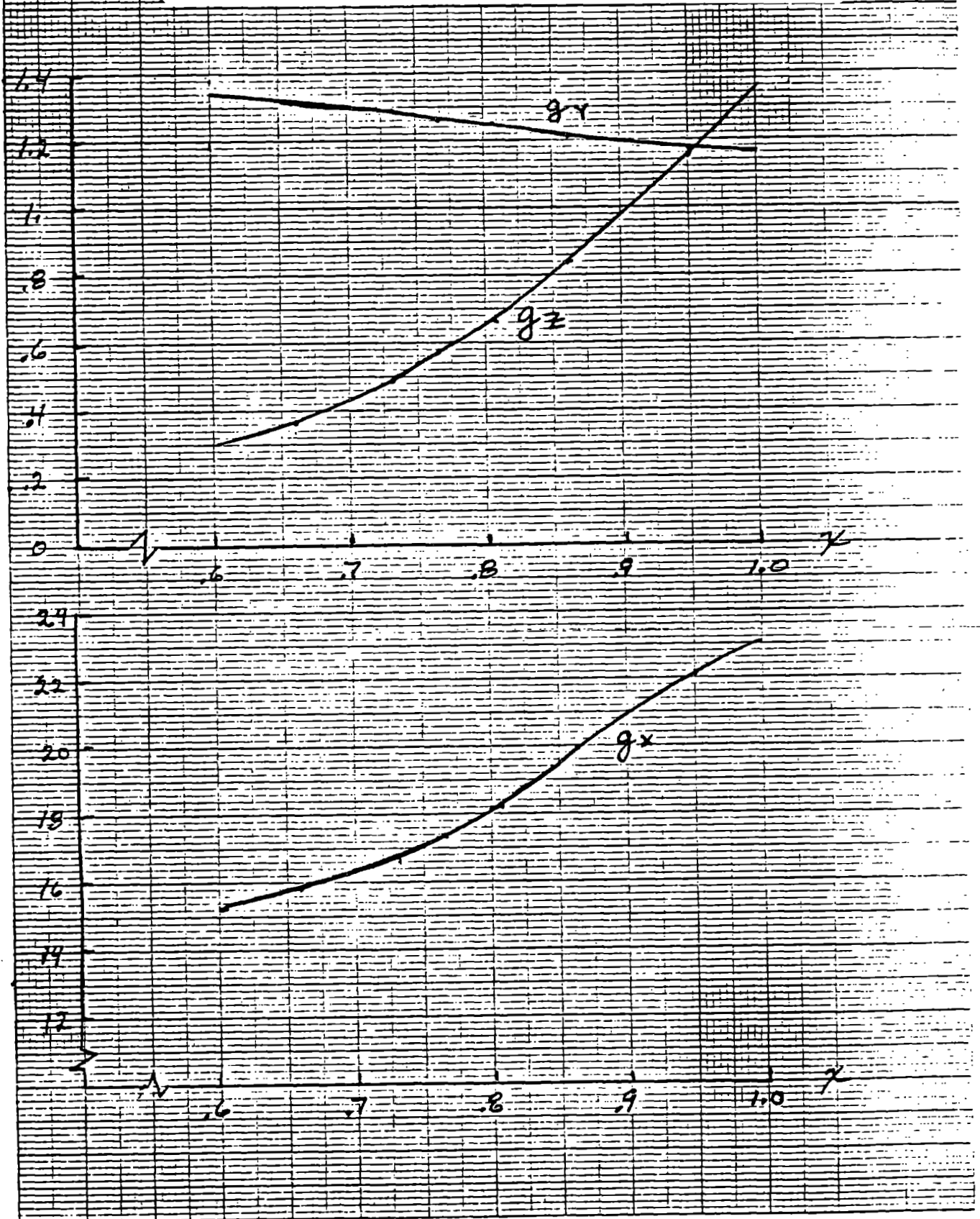
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FIGURE 3.2.1.3-D - AILERON HINGE MOMENT $\sim M_{HA}$



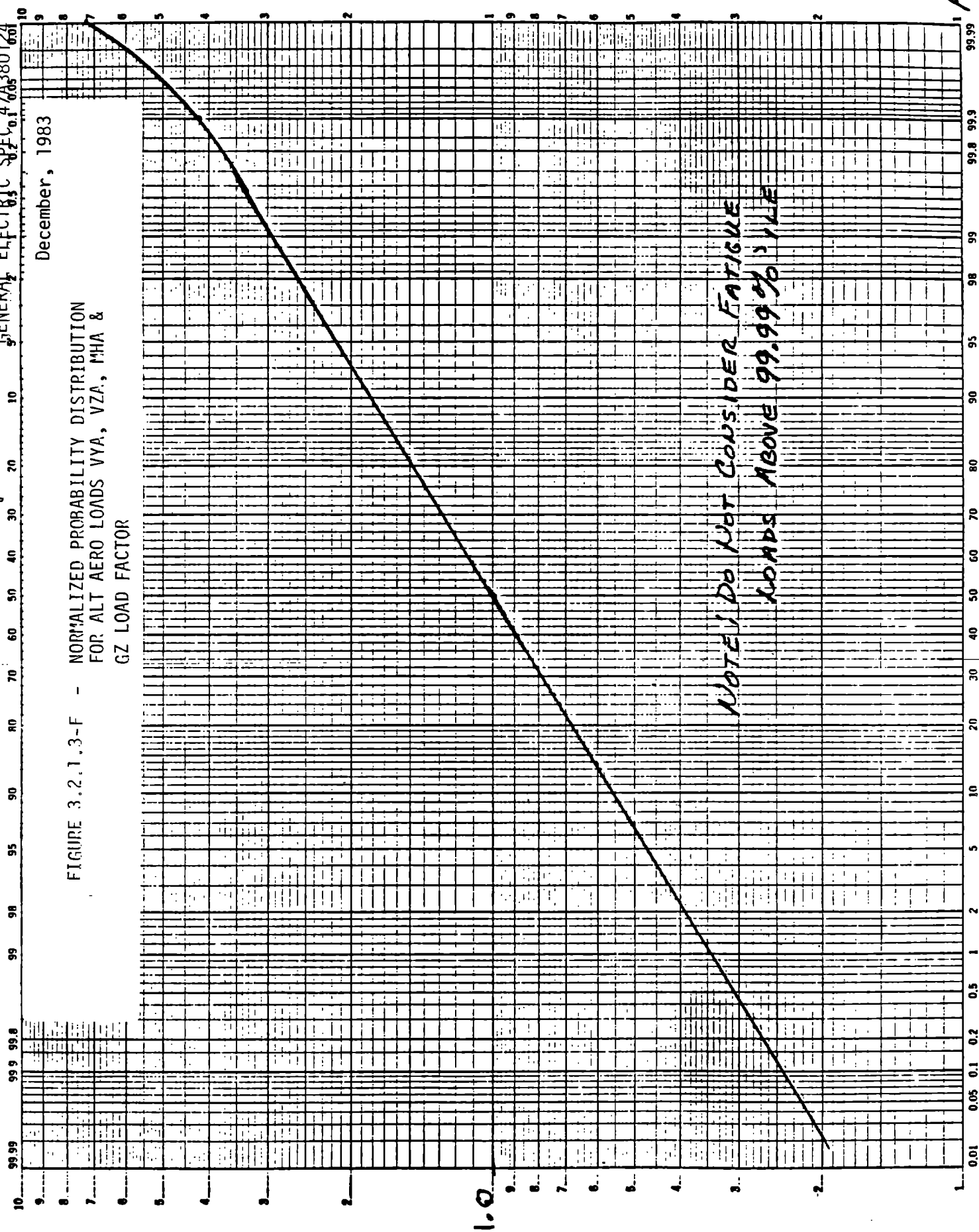
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FIGURE 3.2.1.3-E - G-FACTORS FOR MEAN FATIGUE
LOADS



MOD-5A WTG AILERONS
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FIGURE 3.2.1.3-F - NORMALIZED PROBABILITY DISTRIBUTION
FOR ALT AERO LOADS VVA, VZA, MHA &
GZ LOAD FACTOR



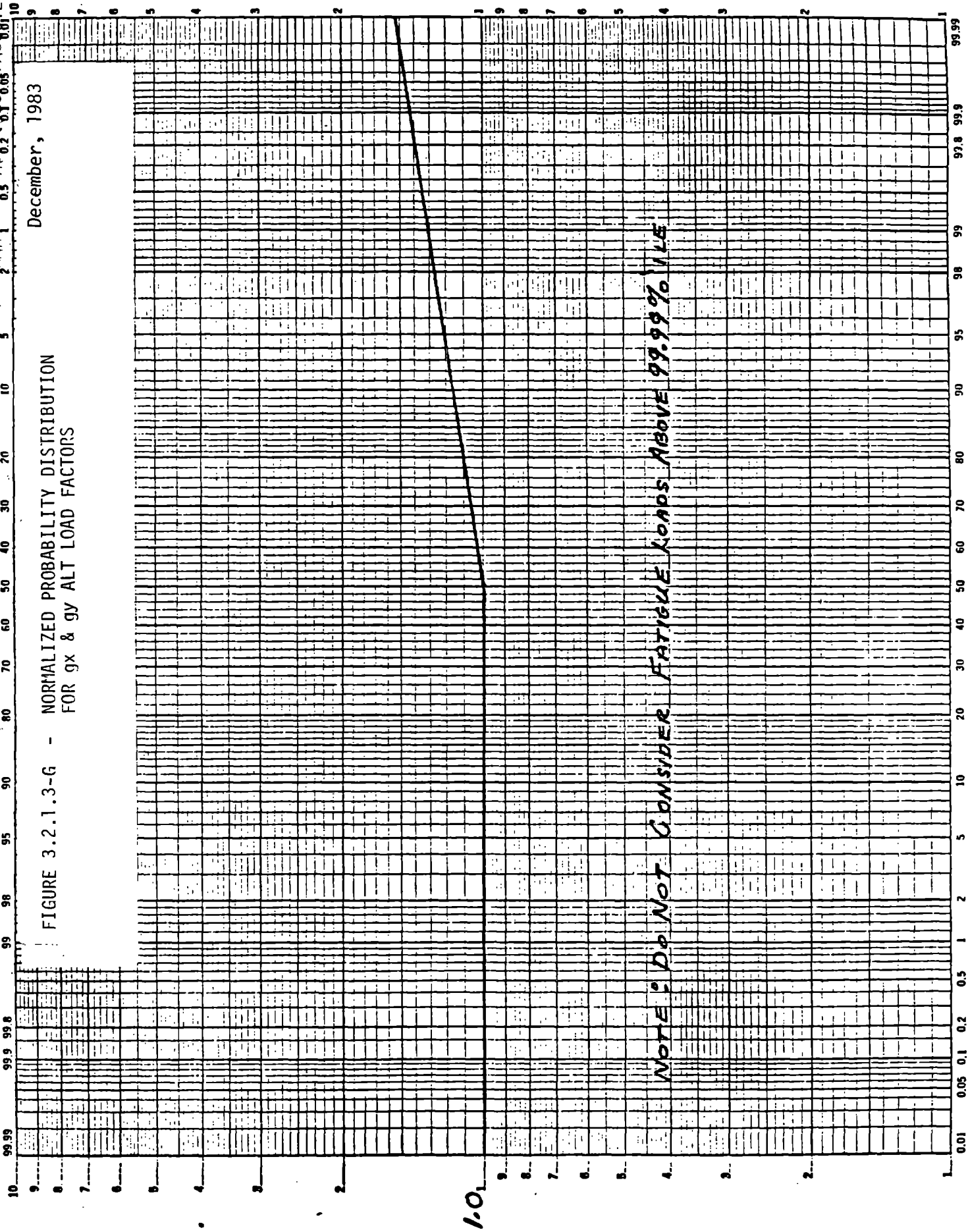
NOTE: DO NOT CONSIDER FATIGUE
LOADS ABOVE 99.99% VILE

P(%)

MOD-5A WTG AILERONS
GENERAL ELECTRIC 380, 24
0.3 0.2 0.1 0.05

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FIGURE 3.2.1.3-G - NORMALIZED PROBABILITY DISTRIBUTION
FOR gx & gy ALT LOAD FACTORS



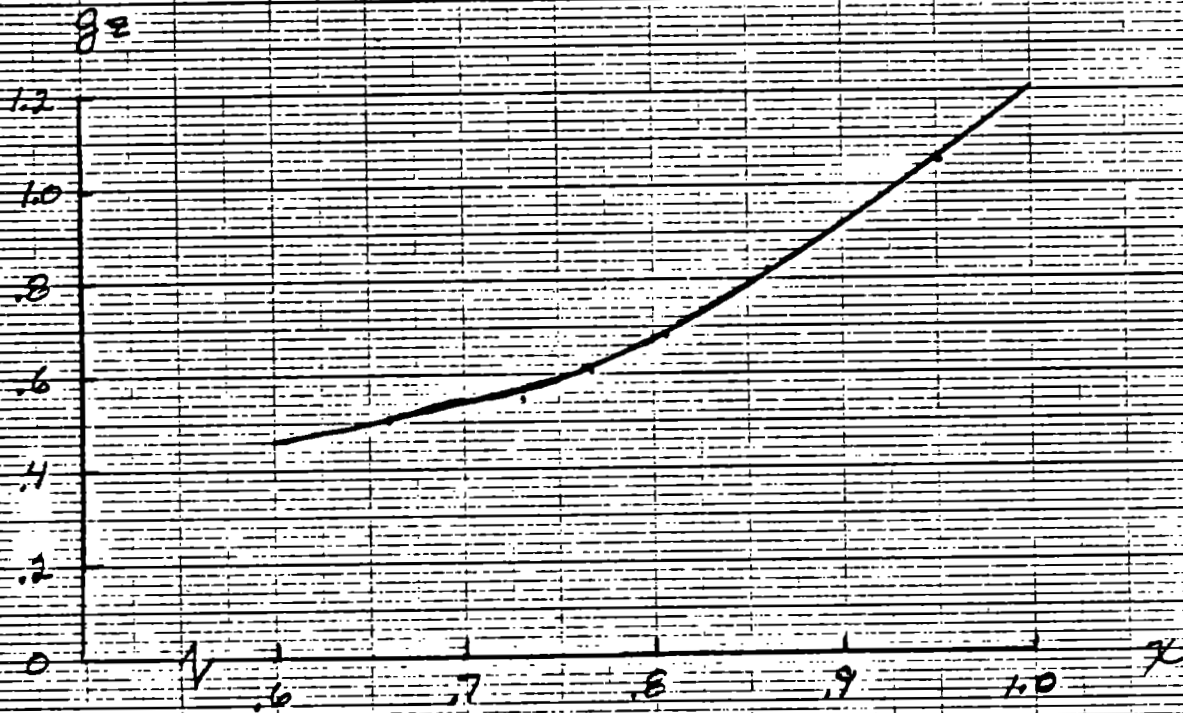
NOTE: Do Not Consider Fatigue Loads Above 99.99% PILE

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P(%)

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FIGURE 3.2.1.3-H - G-FACTOR FOR ALTERNATING
FATIGUE LOADS



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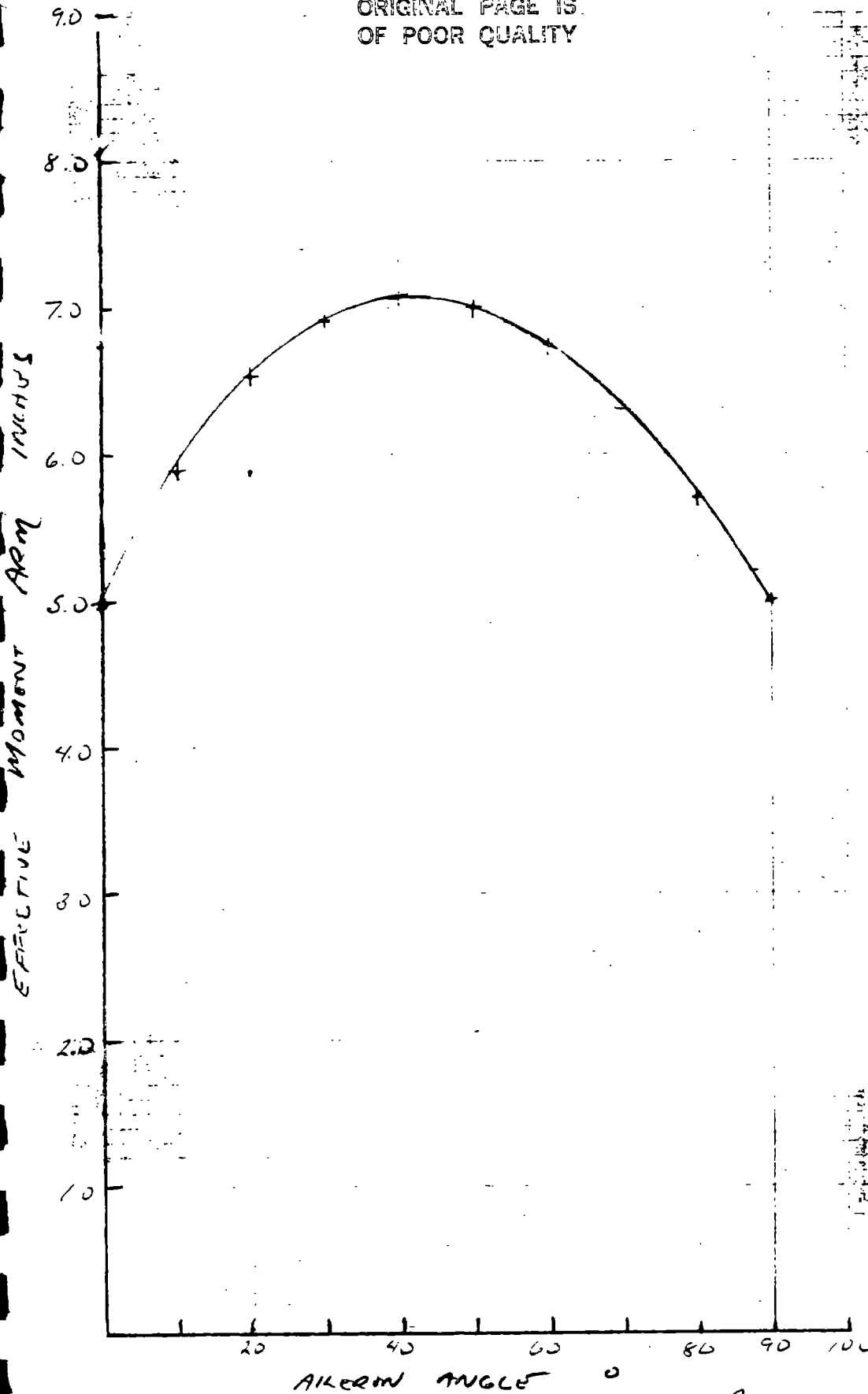


FIGURE 3.2.1.4
ACTUATOR EFFECTIVE MOMENT ARM

December, 1983

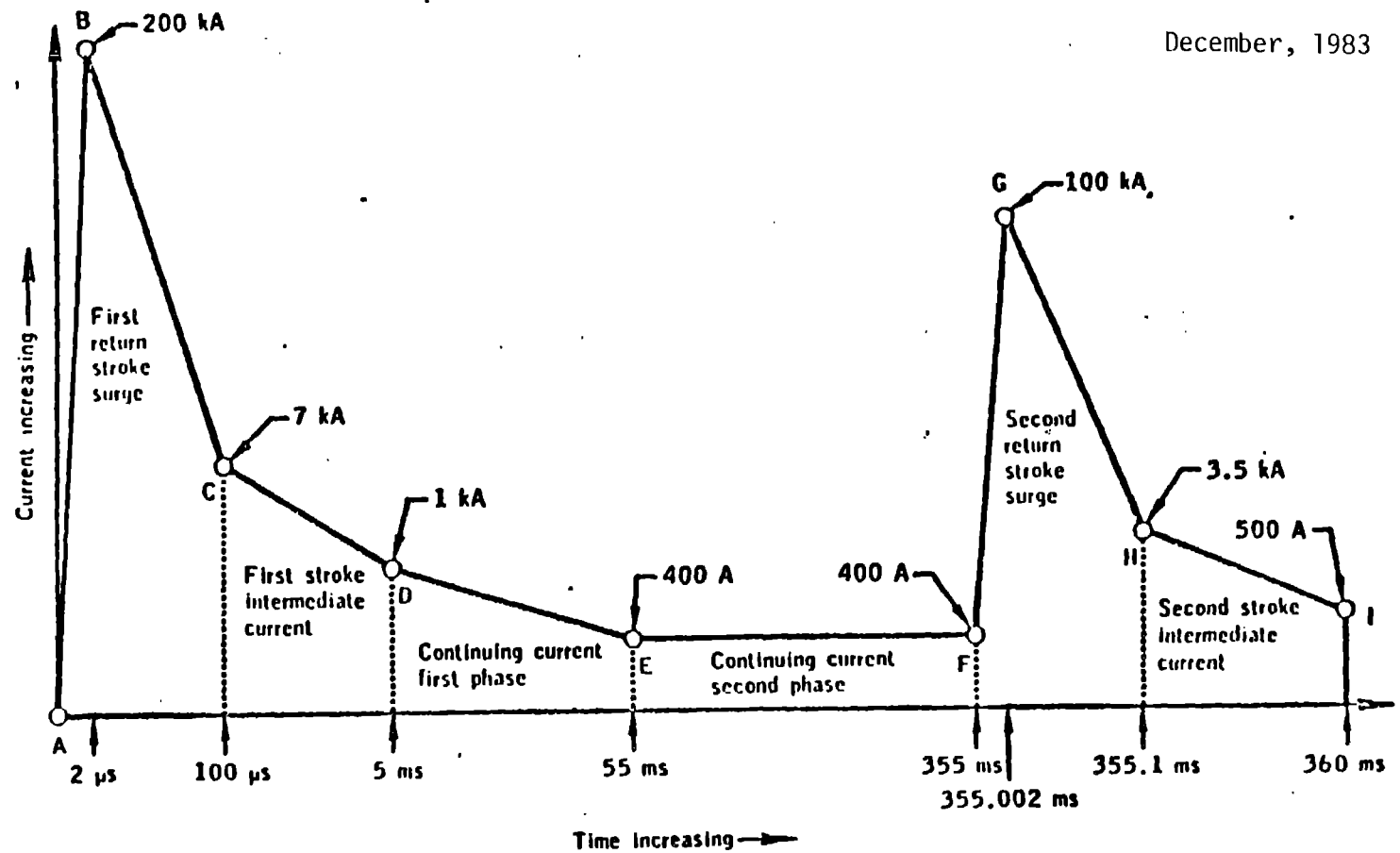


Figure 3.3.3

- Diagrammatic representation of lightning model.
(Note that the diagram is not to scale.)

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FIRST MADE FOR

REVISION

SPECIFICATION

FOR

MOD-5A WTG

DOUGLAS FIR VENEER

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PRINTS TO

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APPROVALS

A.E.P.

DEPT.

47A380126

ISSUED

W.C. Pijawka *4/29/84*

KING OF PRUSSIA, PA. LOCATION

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SECTION 1.0

SCOPE

This specification defines the requirements of blade grade Douglas Fir Veneer to be used in the blade structure of the MOD-5A Wind Turbine.

SECTION 2.0
APPLICABLE DOCUMENTS

The following documents, and all pertinent amendments thereto, of the issue in effect on the date of procurement action shall become a part of this specification to the extent specified herein.

2.1 GOVERNMENT SPECIFICATIONS

Voluntary Product Specification PS 1-74, "Construction and Industrial Plywood", U.S. Dept. of Commerce.

2.2 G.E. DRAWINGS

Drawing 47J381097	Outer Blade Section
Drawing 47J382287	Center Blade Section
Drawing 47J381090	Inner Blade Section
Drawing 47J381089	Trailing Edge Section

SECTION 3.0
REQUIREMENTS

3.1 REQUIREMENTS

The material covered by this specification shall be produced under controlled conditions so as to obtain a consistently good quality veneer complying with requirements stipulated herein.

3.2 MATERIAL

All veneer shall be Douglas Fir and smoothly cut from heartwood and/or sapwood into panels either 27 or 54 \pm 1 inch wide x 100 \pm 1 inch long x 0.10 \pm .01 inch thick.

3.3 GRADE

All veneer shall be A/B grade as defined in U.S. Product Standard PS-1-74, "Construction and Industrial Plywood". It is expected that the quantity of A and B grade veneers respectively included in the processing of a Purchase Order will be commensurate with the quantity of A and B grade veneers present in a typical production mix of A and B.

3.4 MOISTURE CONTENT

Veneer shall be dried to an average moisture content ranging between 3% and 4% in a standard veneer dryer controlled by temperature, speed, and damper settings. Dryer temperature shall not exceed 350°F (177°C).

3.4.1

Veneer moisture content shall be monitored by the electrical resistance method. The final moisture determination, however, shall be by the oven drying method described in U.S. Product Specification PS 1-74. Final moisture content shall be determined on at least 5 different sheets of production run veneer by cutting square samples (10" x 10", or 12" x 12") from sheets which do not meet all requirements of this specification.

3.5 MODULUS

Each dried sheet shall be individually tested for apparent elastic modulus by ultrasonic scanning using a Metriguard Model 2600 veneer grader, or other approved equivalent system. All veneer determined to have an elastic modulus (as measured parallel to grain) below 2.10×10^6 psi shall be rejected for use in this program. Veneer having a modulus of at least 2.45×10^6 psi, when ultrasonic pulse time (UPT) ranges between 360 and 410 microseconds, shall be identified as Blade Grade 1 (BG1) veneer per section 3.6 instructions. Veneer having a modulus of 2.10 to 2.44×10^6 psi, when UPT is between 411 and 440 microseconds shall be marked as Blade Grade 2 (BG2) material per section 3.6 requirements.

3.6 MARKING VENEERS

Different color dye shall be used to identify the apparent elastic modulus of Blade Grade veneer per Figure 1. The dye shall be compatible with laminating epoxy, 47ALATER.

3.6.1 BG1

Veneer shall be marked as follows:

- (a) Primary Mark - A spot of purple dye located in an area not more than 12 in. either side of the centerline of the sheet that runs perpendicular to the grain direction.
- (b) Secondary Mark - Red dye shall be sprayed on all 4 sides of a BG1 bunk before packaging.

3.6.2 BG2

Veneer shall be marked as follows:

- (a) Primary Mark - A spot of purple dye located in an area not more than 15 in. from either end of each veneer sheet.
- (b) Secondary Mark - Green dye sprayed on each side of BG2 veneer bunk.

3.7 VISUAL INSPECTION

Each veneer shall be individually examined and found to contain no defects exceeding the limits established below:

<u>Type of Defect</u>	<u>Sheet Width</u>	<u>Maximum Allowed</u>
(a) White Speck	27" & 54"	None
(b) Broken Ends, Edges, Corners	27" & 54"	None
(c) Rough Peel	27" & 54"	None
(d) Any Individual Knot, ⁽¹⁾ Pitch Pocket, or Mechanical Damage	27" & 54"	Up to 1" Diameter
(e) Combination of Knots, ⁽¹⁾ Pitch Pockets, and Mechanical Damage	27"	Aggregate width ⁽²⁾ of all defects: Up to 3", <u>if</u> <u>well scattered in sheet</u>
	54"	Aggregate width ⁽²⁾ of all defects: Up to 6", <u>if</u> <u>well-scattered in sheet</u>

NOTES:

- (1) Sound, tight fitting.
- (2) Measured across the grain.

SECTION 4.0
QUALITY ASSURANCE PROVISIONS

4.1 GENERAL REQUIREMENTS

The veneer supplier shall be responsible for assuring conformance of veneer with the requirements of this specification. G.E. reserves the right to perform any test deemed necessary to confirm veneer quality. When there is a conflict between the veneer supplier results and the blade manufacturer results, G.E. shall have authority for final disposition on acceptance, or rejection, based on mutually agreed test results.

4.2 QUALIFICATIONS

Any change that may be necessary in veneer qualifications due perhaps to a supply situation, shall be reported to G.E. before procurement of the veneer.

4.3 Document Retention

The following data shall be maintained on file by the supplier for each lot of veneer shipped to G.E. and shall be made available to G.E. upon request:

- (a) Maximum dryer temperature and final moisture content, Section 3.4.
- (b) Results of ultrasonic grading testing and yield of each grade, Section 3.5.

SECTION 5.0
PACKAGING & SHIPPING

No more than 4 calendar days after drying and grading, veneer will be banded, wrapped, and shipped to the address specified on the purchase order. To minimize the occurrence of end waviness in the veneer, each bunk of veneer shall be banded in 4 places. Two (2) bands will be placed within 6 in., or less, of the ends and the other 2 symmetrically located between the end bands. The bands should be tensioned sufficiently to secure the bunk and keep the sheets flat during shipment. Each bunk of veneer shall be double wrapped to keep it clean and dry. The first wrap shall be carefully slit at intervals along the bottom edge to prevent any entrapped moisture from collecting in the bottom of the package. The second wrap will function as a protective envelope for the first. No seams will be acceptable on the top of the package. The second wrap shall also be carefully slit at intervals along the bottom edge to allow passage of any entrapped moisture.

5.1 STORAGE

Veneer shall be stored in a dry area. Pieces being prepared for lamination shall be stored in an area of controlled relative humidity and temperature within the range of 45 to 55% R.H. and 65 to 75°F.

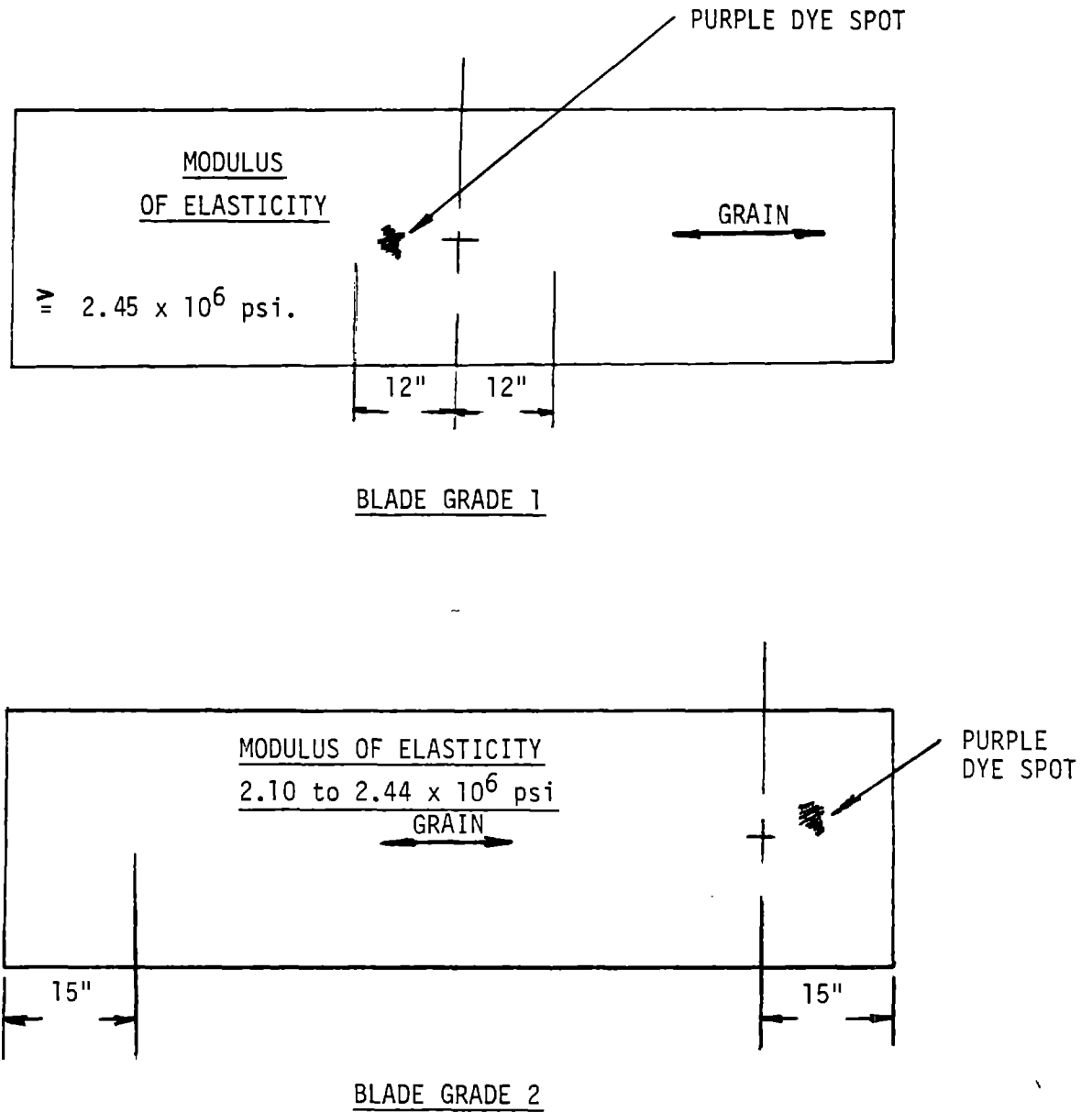


Figure 1

PRIMARY DYE MARKING OF
DOUGLAS FIR VENEER

47A380127

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47A380127			CONT ON SHEET <i>ji</i>	SH NO. <i>i</i>
FIRST MADE FOR				REVISION
<p>SPECIFICATION FOR THE TAPERED ROLLER, ROTOR SUPPORT BEARINGS FOR THE MOD-5A WIND TURBINE GENERATOR APRIL 1984</p> <p><u><i>Serge Dunfey</i></u> DATE: <u><i>4/13/84</i></u> Responsible Engineer</p> <p><u><i>[Signature]</i></u> DATE: <u><i>16 APR 1984</i></u> Engineering Manager</p> <p><u><i>AB</i></u> DATE: <u><i>4/16/84</i></u> Systems Engineering</p> <p><u><i>A. Cheddar</i></u> DATE: <u><i>4-13-84</i></u> Quality Assurance</p> <p><u><i>[Signature]</i></u> DATE: <u><i>4-13-84</i></u> WTG Integration</p> <p>TOTAL NUMBER OF PAGES <u><i>25</i></u></p>				
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ISSUED <u><i>[Signature]</i></u> <u><i>4/19/84</i></u>		<u><i>A. E. P.</i></u> DEPT. <u><i>47A380127</i></u>	WTG <i>500</i>	
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SECTION 1

SCOPE

This specification defines the technical requirements for a tapered roller bearing set which will support the rotor of the MOD-5A Wind Turbine Generator.

SECTION 2
APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein.

DRAWINGS - GENERAL ELECTRIC

47D381081	Tapered Roller Bearing - FWD
47D381080	Tapered Roller Bearing - AFT
47E382441	Yoke/Spindle Assembly - MOD-5A

SPECIFICATIONS - MILITARY

MIL-I-6868	Inspection Process, Magnetic Particle
MIL-I-8950	Ultrasonic Inspection, Wrought Metals
MIL-I-45208	Inspection System Requirements

STANDARDS - MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-271	Non-destructive Testing Requirements for Metals

STANDARDS - GERMAN

DIN-5402	Rolling Bearing Components, Cylindrical Rollers, June 1973
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(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity).

2.1 OTHER PUBLICATIONS

The following documents form part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or requests for proposal shall apply.

AMERICAN IRON AND STEEL INSTITUTE

AISI 52100 Steel, Chromium

AISI E3310 Carburizing Steel

SOCIETY OF AUTOMOTIVE ENGINEERS, INCORPORATED

AMS 2808 Identification - Forgings

(Applications for copies should be addressed to the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York, New York, 10017).

AMERICAN SOCIETY FOR TESTING MATERIALS

ASTM E112-63 Estimating and Average Grain Size of Metals

ASTM A485 Forging Steel

ASTM E45-63, METHOD A Determining the Inclusion Content of Steel

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA, 19103).

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION, INCORPORATED

AFBMA Standards, Section 17, Class 4

(Application for copies should be addressed to the Anti-Friction Bearing Manufacturer's Association, Inc., 60 East 42nd Street, New York, NY, 10017).

SECTION 3 REQUIREMENTS

Requirements for individual bearings shall be as specified herein and in accordance with GE Dwgs. 47D381080 and 47D381081 or equivalent configurations which are within the envelope defined on the drawings.

3.1 PERFORMANCE CRITERIA

3.1.1 LOADING

The loads are applied from the outer race (rotating) to the stationary inner race.

3.1.2 LIFE REQUIREMENTS

The bearing shall be capable of operating for a minimum of 228×10^6 revolutions, when subjected to the requirements of Section 3.1.3 and 3.1.4. The failure rate of the bearing shall be less than 2% over the 30 year life of the WTG.

3.1.3 ROTOR SUPPORT REQUIREMENTS

The rotor bearings shall be mounted on the stationary hub of the rotor support structure to support the rotor. The bearings, accordingly, must be capable of resisting the loads imposed by the mass and dynamics of the rotor system. GE drawing 47E382441 shows the specific bearing arrangement and mounting geometry. Table 1 lists pertinent performance requirements.

TABLE 1 - PERFORMANCE REQUIREMENTS

Input Speed - Nominal	16.8 RPM (50% of time)
Input Speed - Low	13.7 RPM (44% of time)
Maximum Speed - 50% Overspeed	25 RPM
Non-rotating	6% of time
Maximum Running Losses/Bearing	1/3% at rated power (33 HP @ 16.8 RPM)
Direction of Rotation	Clockwise when looking along low speed shaft into the gearbox. Outer race rotation.
Design Load	See Drawing 47D381080 and 47D381081

3.1.4 ENVIRONMENTAL CONDITIONS

The assembled bearings shall be capable of meeting the requirements of this specification during and/or after exposures to a temperature range of 0°F to +100°F, and exposure to salt spray as found in coastal areas. The bearing shall survive, without degradation, a temperature range of -40°F to +120°F, non-operating.

3.1.5 WEIGHT

The weight of the assembled bearing, less any attaching devices or sealing hardware, shall not exceed the weight shown on the referenced drawing.

3.2 DESIGN AND CONSTRUCTION

3.2.1 GENERAL

The design and construction of the bearing shall not exceed the envelope shown on the respective GE Dwg. specified in the purchase order.

3.2.2 STRUCTURAL INTEGRITY

The inner and outer races of the bearing must be capable of operating with defects of the size and location defined per MIL-I-8950 Class B without propagation to the point of structural failure. Structural failure is defined as the inability of the race structure to support the rotor for the specified life when the bearing is subjected to the load conditions defined in Section 3.1 of this specification. Sufficient information to perform a fracture mechanics analysis shall be provided to the procuring activity.

3.2.3 LUBRICATION AND SEALING

The rollers and cages of the bearing will be grease lubricated with Mobil Mobilux EP 111 or equal. This lubricant will be supplied from an automatic lubrication pump. Provisions for lubricant fittings, and distribution and circulation of the lubricant within the bearing, shall be the responsibility of the purchaser. The manufacturer shall recommend the grease seal design to keep the rate of grease injection to a minimum and to protect the bearing under the environmental conditions shown in paragraph 3.1.4

3.2.4 ROLLER CAGE

The cage must be designed to withstand all roller loading without detrimental wear for the specified life of the bearing when subjected to the loads defined on the referenced drawing. For pin type cages the vendor shall specify hardness, surface finish and internal clearance.

3.2.5 FITS AND TOLERANCES

3.2.5.1 Fits

The manufacturer shall specify fits of the bearing with the housing and shaft at a reference temperature of 20°C.

3.2.5.2 Runout

The maximum axial runout of the inner race rotating relative to the outer race shall be 0.005" T.I.R. The maximum radial runout of the inner race rotating relative to the outer race shall be 0.0035" T.I.R. These tolerances apply at the nominal loads shown on drawing for radial readings.

3.2.5.3 Roller Diameter Variation

The average diameter of the rollers within a row of the bearing shall be matched within .0002".

3.2.5.4 Internal Diametral Clearance - Installed

The internal diametral clearance shall be .002" to .008".

3.2.6 SURFACE ROUGHNESS

Surface roughness shall be 125 RMS max. except as follows:

Raceways:	12 RMS max.
Rollers:	8 RMS max.

3.3 MATERIALS

3.3.1 RACES

Material shall be forged and rolled ring steel per ASTM A485 Grade 2, or AISI 4340. The steel shall be of the electric furnace, vacuum degassed process.

3.3.2 ROLLERS

Material shall be AISI E-3310 modified carburizing steel, or AISI E-52100 through hardening steel. The steel shall be of the vacuum remelt process. Rollers shall be crowned per DIN 5402.

3.3.3 ROLLER CAGES AND PINS

Materials must be compatible with the loads, speeds and lubrication defined in paragraphs 3.1 and 3.2 of this specification.

3.3.4 SPECIFICATION CONTROL

Vendor shall verify specification control procurement of all materials.

3.3.5 INCLUSION RATING AND CLEANLINESS

Race Material cleanliness, as determined in paragraph 4 (.2.7[A]) of ASTM E45-63, Method A, shall not exceed the following Jernkontoret (JK) levels:

Inclusion Rating, Worst Field

<u>Type</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Thin	1.5	1.5	2.0	1.5
Heavy	1.0	1.0	1.5	1.0

3.4 HEAT TREATMENT AND HARDNESS

3.4.1 RACES

Rough machined forgings shall be fully spheroidized annealed. No pearlitic structure, ferrite network or carbide network shall be allowed. The maximum hardness of the rough machined forgings shall be 220 BHN.

3.4.2 ROLLER PATH HARDNESS

Roller paths on the inner and outer races shall be hardened and tempered (375°F min.) to a surface hardness of 58 Rc to 62 Rc to a minimum depth of 0.5 inches. Grain size shall be 5 or finer.

3.4.3 TEST BARS

One test bar, at least 16 inches long, with cross section representative of the races, and of the same heat of material shall be heat treated in the same lot as the bearing races. A cross section approximately one inch thick shall be taken near the center of each bar. The cross section shall be metallurgically polished and etched. One hardness traverse (hardness vs. depth below surface) shall be made on each roller path near the center of roller loading. The polished, etched, and hardness tested cross sections and a written report of the hardness traverses shall be supplied to the procuring activity with each order for bearings.

3.4.4 ROLLERS

Rollers shall have a surface hardness of 58 Rc to 62 Rc after grinding. When using a case hardenable steel, the depth of case (where the minimum hardness shall be 50 Rc) shall be .200" minimum and with a minimum core hardness of Rc 35 to prevent case or core fatigue failure when the bearing is subjected to the load conditions specified in paragraph 3.1 of this specification. Grain size shall be 5 or finer.

3.5 WORKMANSHIP

The bearing shall be constructed in a thorough workmanlike manner. All parts shall be free of burrs, sharp edges and other damages or defects that could make the unit unsatisfactory for the operation or function intended.

3.6 IDENTIFICATION MARKINGS

3.6.1 GENERAL

Identification marking shall be in accordance with MIL-STD-130 and shall include the following:

- a) Manufacturer's name, symbol, or code identification
- b) Manufacturer's part number, lot number and serial number

3.6.2 LOCATION AND TYPE OF MARKING

Marking shall be electro-etched with 1/4" high characters located in a non-loaded zone.

3.6.3 FORGINGS

Forgings shall be identified in accordance with AMS 2808. Material that cannot be identified at destination shall be cause for rejection.

3.7 LIFTING PROVISIONS

Each race shall contain tapped holes for eye bolts as shown on referenced drawing. Eye bolts with a strength safety factor of six (6) shall be provided with each race.

SECTION 4

QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

4.1.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection and tests specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the procuring activity. The procuring activity reserves the right to perform any of the inspections and tests set forth in this specification where such inspections and tests are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 INSPECTION PROVISIONS

4.2.1 TEST PROCEDURE

4.2.1.1 Preparation

The procedure and methods for performing all tests specified herein shall be prepared by the supplier.

4.2.1.2 Approval

Test procedures shall be submitted to the procuring activity for approval prior to initiation of formal testing. The procuring activity reserves the right to require additional tests to determine compliance with the requirements of this specification.

4.2.2 CLASSIFICATION OF TESTS

Tests shall be classified as follows:

- a) Acceptance test (see 4.3)

4.2.3 TEST CONDITIONS AND TOLERANCES

4.2.3.1 Temperature

All static and dynamic tests shall be performed at room ambient temperature.

4.2.3.2 Dimensional Checks

All dimensions shall be measured using instruments calibrated to reference standards at 20°C. The reference standard to be certified by the National Bureau of Standards. Standard gauges shall be used for checking all radii chamfers, tapped, and drilled holes.

4.2.4 MAGNETIC PARTICLE INSPECTION

4.2.4.1 Non-Operating Surfaces

The non-operating surfaces, other than roller paths, shall be inspected 100% by magnetic particles per MIL-I-6868 using the wet method.

4.2.4.1.1 Acceptance Criteria

Any indications of the following types are not acceptable:

- a) Cracks deeper than .010. No crack shall extend into a hole or fillet. All cracks less than .010 shall be relieved.
- b) Seams and laps deeper than .010. No seams or laps shall extend into a hole or fillet. All seams and laps shall be relieved.
- c) Surface indications caused by flaking, forging burst, intruded forging scale deeper than .010 and/or covering more than 15% of the surface.
- d) Corrosion pits except for isolated areas no larger than .0625 diameter by .010 deep.

4.2.4.2 Rings Including Roller Paths

The finished rings and roller paths shall be inspected 100% by magnetic particles per MIL-I-6868 using the wet method.

4.2.4.2.1 Acceptance Criteria

Any indications of the following type are not acceptable: cracks of any type; surface indications caused by flaking, forging burst, intruded forging scale, laps, linear porosity, tears, corrosion pits or non-metallic inclusions.

4.2.4.2.2 Ultrasonic Inspection

Rings shall be ultrasonically inspected as partially machined forgings. No indications are permitted within .1 inch of roller path surface.

4.2.4.2.3 Nital Etch

All roller paths are to be nital etched with a 3% nital solution at 4 equally spaced locations on each roller path over a 2" wide segment at each location. The races are to be cleaned with alcohol and nital etched for 30 seconds. Rewash with alcohol and treat with a 10% solution of NaOH to neutralize the etch. After examination the races shall be coated with a light oil to prevent corrosion.

4.2.4.2.3.1 Acceptance Criteria. No grinding burns or rehardened areas shall be permitted.

4.2.4.3 Rollers

Rollers shall conform to the material specification of 3.3.2 and meet specification requirements of paragraph 3.3.4. Rollers shall be inspected 100% by magnetic particles per MIL-I-6868 using the wet method. Acceptance criteria shall be per paragraph 4.2.4.2.1.

4.2.4.4 Test Pieces

A roller shall be sectioned and microscopically examined and a hardness traverse made to demonstrate compliance with the requirements of paragraph 4.2.4.3. No carbide network shall be permitted.

4.2.5 FINAL NITAL ETCH

Four matched rollers from each lot for use in each specific bearing shall be nital etched by the supplier. These rollers shall not be assembled into the finished bearing. Any indication of grinding burns, cracks, pits or decarburization shall be cause for rejection of the entire lot.

4.2.6 FORGINGS INSPECTION

4.2.6.1 Microstructure

Radial specimens, approximately 0.28" square in surface area, taken midway between center and surface of the test bar, shall be polished on a face longitudinal to the direction of rolling, for microinclusion rating in accordance with the Jernkontoret Chart, Method A, Plate I of ASTM E45. Ratings shall meet the requirements of paragraph 3.3.5 of this specification.

4.2.6.2 Macrostructure

Visual examination of transverse sections from billets, etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at 160-180°F for sufficient time to develop a well-defined macrostructure, shall show no imperfections such as pipe cracks, porosity segregation and inclusions which may be detrimental to fabrication or performance.

4.2.6.3 Ultrasonic Inspection

All forgings shall be ultrasonically inspected for soundness per MIL-I-8950, Class B. All significant indications shall be noted and the material identified so that subsequent re-examination can be made. Rings shall be free of all harmful defects.

4.2.7 QUALITY CONFORMANCE INSPECTION

Each unit shall be examined and acceptance tested per paragraph 4.3.

4.2.8 TEST SUCCESS CRITERIA

Any deviation from the performance parameters specified herein/or any physical/mechanical out-of tolerance condition that is noted during or after the performance of the tests specified herein shall constitute a failure of the unit.

4.3 ACCEPTANCE TEST

Each unit shall be subjected to and shall have passed the following tests prior to acceptance by the procuring activity.

TEST	TEST METHOD REFERENCE
Examination of Product	4.3.1
Identification	4.3.2
Weight	4.3.3
Workmanship	4.3.4
Performance	4.3.5

4.3.1 EXAMINATION OF PRODUCT

Examine each unit for strict conformance to 3.2.1 and 3.2.6

4.3.2 IDENTIFICATION

Examine each unit and check for conformance to the requirements of 3.6.

4.3.3 WEIGHT

Weigh each unit for conformance to drawing.

4.3.4 WORKMANSHIP

Examine each unit to verify conformance to 3.5

4.3.5 PERFORMANCE TESTS

Each unit shall be tested in accordance with the approved acceptance test procedure submitted in accordance with 4.2.1. The tests shall include measurement of breakaway and running torque under weight of the races only, with the bearing axis in the horizontal position.

4.3.6 ACCEPTANCE INSPECTION

Acceptance Inspection of rollers shall be performed by sampling per MIL-STD-105, Level II, AQL 1.0% defective.

The certified reports shall be submitted as an attachment to the shipping papers. The report shall include the following as part of the certification:

- a) Chemical composition of races, rollers and cages.
- b) Heat number of rollers, races and test bars.
- c) Photomicrographs of races and rollers test sample at 500 x showing core and surface microstructure, and case hardening pattern.
- d) Surface and case hardness traverse (Rc) of races and rollers and roller paths. Hardness of rough machined forgings (BHN). Core hardness of races and rollers (Rc).
- e) Depth of race and roller path case in thousandths of an inch.
- f) Heat treat lot number of races, rollers and appropriate test bars.
- g) For through hardened races, one hardness traverse (hardness vs. depth below surface) shall be made on each roller path of the test bar near the center of the roller loading (minimum of two hardness tested cross sections) and a written report of the hardness traverse shall be supplied to the procurer for each order of bearings. See paragraph 3.2.4.
- h) Grain size of rollers and races per ASTM E112-63.
- i) Cleanliness ratings per ASTM E45, Method A.
- j) Results of magnetic particle inspection per MIL-I-6868.
- k) Results of ultrasonic inspection per MIL-I-8950, Class B noting all discrepant defects.

2.3.6 ACCEPTANCE INSPECTION (cont'd)

- l) Results of macro acid etch per paragraph 4.2.6.2.
- m) Results of nital etch inspection showing that no grinding burns exist.
- n) Torque or Performance Test.
- o) Results of dimensional checks.

SECTION 5
PREPARATION FOR DELIVERY

The completely assembled bearing shall be prepacked with Mobilux EP 111 Light or equal, grease and tire wrapped per manufacturer's commercial practice. Kraft paper shall not be used. The bearing shall be crated for shipment and shall be constructed in a manner that will preclude damage or contamination.

SECTION 6.0

NOTES

6.1 ORDERING DATA

Procurement documents should specify the following:

- a) Title, number, and date of this specification.
- b) Number of the applicable detail specification and the revision letter.
- c) Levels of preservation, packaging, packing, and applicable marking.
- d) Method of sampling if other than specified.

6.2 CERTIFICATION

All quality conformance inspection data shall be recorded and a copy submitted to the procuring activity along with a notarized certificate of conformance at the time of bearing delivery. The data shall include all those listed in paragraph 4.3.6

1. Report No. NASA CR-174737		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle MOD-5A Wind Turbine Generator Program Design Report Volume IV - Drawings and Specifications Book 3				5. Report Date August, 1984	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No.	
				10. Work Unit No.	
9. Performing Organization Name and Address General Electric Company Advanced Energy Programs Department P.O. Box 527 King of Prussia, PA 19406				11. Contract or Grant No. DEN 3-153	
				13. Type of Report and Period Covered Contractor Report	
12. Sponsoring Agency Name and Address U.S. Department of Energy Conservation and Renewable Energy Division of Wind Energy Technology Washington, D.C. 20545				14. Sponsoring Agency Code DOE/NASA/0153-4	
15. Supplementary Notes Final report. Prepared under Interagency Agreement DE-AI01-79ET20305. Project Manager, T.P. Cahill, Wind Energy Project Office, NASA Lewis Research Center, Cleveland, Ohio 44135					
16. Abstract This report documents the design, development and analysis of the 7.3MW MOD-5A wind turbine generator covering work performed between July 1980 and June 1984. The report is divided into four volumes: Volume I summarizes the entire MOD-5A program, Volume II discusses the conceptual and preliminary design phases, Volume III describes the final design of the MOD-5A, and Volume IV contains the drawings and specifications developed for the final design. Volume IV contains the drawings and specifications that were developed in preparation for building the MOD-5A wind turbine generator.					
17. Key Words (Suggested by Author(s)) Renewable energy; Wind energy Wind power; Variable speed generator Wind turbine design; Wind turbine system; Wood rotor blades; Large scale wind turbine			18. Distribution Statement Unclassified - unlimited STAR Category - 44 DOE Category - UC-60		
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